AIR POWER History

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COVER: "Fortress on the Plains" is a life-size metal silhouette honoring the men, women and aircraft of World War II. The sculpture portrays the world famous Boeing B-17 "Flying Fortress" along with support personnel, air and ground crews. (*Continued on page 3.*)

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From the Editor

In the lead article, Rick Sturdevant guides us on a complex journey "From Satellite Tracking to Space Situational Awareness: The USAF and Space Surveillance, 1957-2007." He makes the fifty-year-long evolution easier to understand by presenting it in several distinct phases: 1957-1964, 1964-1971, 1971 -1998, and 1998 to the present. Sturdevant shows how space tracking and surveillance were affected by scientific advances, global political and military considerations, and inter-service rivalries among U.S. military departments.

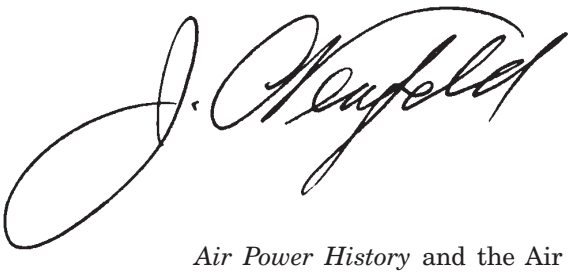
During the interwar years from 1919 to 1940, strategic air bombardment theorists assumed that existing technology would permit the bombers to "always get through" to their targets and destroy them with pinpoint accuracy. Unfortunately, however, that technology was not as yet available. Consequently, the theorists and planners abandoned precision bombing in favor of area bombing. In the second article, Dan Haulman tracks the "rise, fall, and resurrection" of precision air bombardment from World War II to today.

By the summer of 1989, Panamanian dictator General Manuel Noriega and his underlings had annulled a free election, beaten up opposition candidates, and stepped up attacks against American troops and civilians. The last straw emerged in December, when the Panama Defense Forces killed a U.S. Marine Corps officer, prompting President George H. W. Bush to launch Operation Just Cause. In the third article, Stetson Siler, an Air Force officer assigned to U.S. Southern Command's J-5, recounts his observations of Just Cause, in terms of the operation's planning; command and control; cooperation and integration; and civil affairs.

In the fourth article, Marshall Michel asks rhetorically whether the P–51 Mustang was "The Most Important Aircraft in History?" I had suggested that he might be less provocative by changing the subtitle to *the most important fighter in World War II.* But Michel declined (actually, he refused). I sent the manuscript to reviewers, some of whom leaned heavily in favor of the P–47. But Michel "hung tough," rebutting all of the arguments that the Thunderbolt enthusiasts hurled at him. Michel has thrown down the gauntlet. If you have an opinion on this controversy, perhaps some other plane was more important than the P–51, I invite you to weigh in with a letter to the editor.

Lt. Gen. Michael A. Nelson, the President and CEO of the Air Force Historical Foundation, reports on the October 6th Awards Banquet that highlighted the year 2008. (See pages 70 to 72.) He also confirms his decision to complete his five-year-long tenure on December 31st. Those of us who worked with General Nelson can attest to the splendid job he performed in leading the Foundation into the twenty-first century and putting it on solid fiscal ground.

We are saddended to report the death of Lt. Col. Maynard Y. "Bing" Binge, USAF (Ret.), a former member, trustee, supporter, and Executive Director of the Air Force Historical Foundation. He will be sorely missed. (See page 75.)



COVER (*continued*): This one-of-a-kind aviation sculpture by artist Brian Norwood is located at the Hobbs Industrial Air Park in Hobbs, New Mexico—site of the former Hobbs Army Air Field. From 1942 to 1946, HAAF served as a transitional training base where pilots learned to fly four-engine B-17 bombers. The sculpture stands nineteen feet tall and stretches for more than 80 feet from end-to-end. Funded by the City of Hobbs, it was dedicated on November 11, 2008.

From Satellite Tracking to Sp
The USAF and Space Surve

pace Situational Awareness: eillance, 1957–2007

Rick W. Sturdevant

(Overleaf) NAVSPASUR transmitter site, Lake Kickapoo, Texas, 1993. *(Photo by T. Kneisel) (Unless otherwise credited, all photos courtesy of the author.)*

In 2007, discussions about the need to improve space situational awareness (SSA) abounded among senior leaders in the United States Air Force (USAF), elected officials, corporate executives, and a host of others worldwide who relied on satellite systems. As one expert explained, SSA—"the ability to 'see' and understand what is going on in space"—provided the "foundation stone" for all operations in that domain. It ensured that working satellites did not interfere with one another, that collisions with detectable debris could be avoided, and that reasons—natural, nefarious, or other—for satellite ailments could be accurately diagnosed.[1] From a military perspective, Gen. Kevin P. Chilton, commander of Air Force Space Command (AFSPC), focused first and foremost on SSA, because he needed "to not only catalog but also understand what is up there, to understand when a satellite maneuvers, to understand when something is deployed off a satellite or a bus, and ultimately to be able to determine the capabilities of the satellite and the intent of the operator."[2] Fundamental to meeting demand for improved SSA in 2007 was the U.S. Space Surveillance Network (SSN) that had evolved over a half century for detecting, tracking, identifying, and cataloging all man-made objects in outer space.

"THE ABILITY TO 'SEE' AND UNDERSTAND WHAT IS GOING ON IN SPACE"—PROVIDED THE "FOUNDATION STONE" FOR ALL OPERATIONS IN THAT DOMAIN

Evolution of the SSN occurred in several phases. The first phase, which lasted seven years (1957-1964), focused on the fundamental requirement for detection, tracking, and identification of a small but growing number of artificial earth-orbiting satellites and assorted pieces of space debris. Efforts to establish a Space Defense Center deep underground in Cheyenne Mountain and to meet more demanding requirements for computational precision, better network communications, improved tracking capacity, accurate decay predictions, and anti-satellite (ASAT) support marked a second phase (1964-1971). More foreign satellites in higher-altitude orbits, greater need for timely warning and verification of attacks on U.S. space assets and, somewhat later, preparations for an experimental, air-launched U.S. ASAT system, along with creation of a Space Defense Operations Center to replace the Space Defense Center, constituted a third phase (1971-1998). Pursuit of SSA as an essential first step toward achieving and maintaining space control signaled the emergence of a fourth phase (1998-present).

A nagging concern among U.S. Presidents and their national security advisers underlay all these phases. From Dwight D. Eisenhower to George H.W. Bush, Presidents confronted a nuclear-armed, openly confrontational Soviet Union in a Cold War—one where, after 1957, the arsenals included intercontinental ballistic missiles and earth-orbiting satellites. Mindful of the surprising blow Japan struck against the United States on December 7, 1941, U.S. political and military leaders remained acutely sensitive to avoiding another "Pearl Harbor," regardless of whether the attack came from land, sea, air, or space. As the role of space-based platforms in reconnaissance, surveillance, early warning, and communications became increasingly vital to national security, especially to guarding against surprise attack on North America, safeguarding those platforms became increasingly important. The collapse of the Soviet Union and the end of the Cold War did little to dampen that sensitivity among later Presidents, because the number of nations with nuclear weapons, long-range rockets, and a potentially hostile presence in space was on the rise. The world of the early twenty-first century appeared just as dangerous, perhaps more dangerous, than the Cold War era. Therein lay the most compelling reason for the maturation of satellite tracking into space situational awareness.

Phase One: 1957-1964

Plans for satellite tracking began in early 1955, preparatory to launching the first U.S. earth satellite for the International Geophysical Year (IGY), scheduled from July 1957 through December 1958. Convinced that an object in orbit could be acquired optically by observers with binoculars or Askania-type cameras, Harvard University's Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory (SAO), arranged for Ohio State University's Dr. J. Allen Hynek to head a program sometimes referred to as SPOT (Smithsonian Precision Optical Tracking). Whipple and Hynek arranged for renowned optician Dr. James G. Baker and mechanical specialist Joseph Nunn to collaborate on designing a high-precision, satellite-tracking camera based on the Super-Schmidt camera developed for the Harvard Meteor Project in the 1940s. Meanwhile, recognizing the need to detect the satellite visually and obtain sufficiently precise, preliminary orbital data for the twelve SAO Baker-Nunn stations to know where to point their cameras, Whipple prevailed upon

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(Top) Moonwatch telescope operators, ca. 1958.

(Above) Moonwatch analysts, ca. 1958.

"Operation Moonwatch" teams of volunteer, amateur astronomers worldwide to report their visual observations.[3]

Several Moonwatch teams and individual participants in the western United States would become interested in precision satellite spotting as early as 1959. With financial support from North American Aviation's Space and Information Systems Division and the U.S. Air Force's Air Defense Command (ADC), those teams formed the Western Satellite Research Network (WSRN). One volunteer in particular, Professor Arthur S. Leonard of Davis, California, proved so adept at detection and precise observation of small, faint objects that ADC officers concluded Moonwatch could provide better identification of space objects than mechanical radars. Intended originally to last only for the duration of the IGY and to track at most a handful of U.S. satellites, Whipple's SAO optical network would continue its operations into the 1970s.[4]

Despite most upper-air research scientists' confidence in optical methods for tracking the first U.S. satellite, Milton Rosen, who was technical director for the Vanguard project, had doubts. Consequently, he asked John T. Mengel's Tracking and Guidance Branch at the Naval Research Laboratory (NRL) to develop an electronic detection and tracking system for use in conjunction with the optical one. Using radio interferometry to triangulate signals transmitted from a satellite, Mengel's assistant Roger L. Easton designed the Minitrack system. Ultimately, Minitrack included fourteen ground installations situated mostly on a north-south "fence" or "picket" line that stretched along the east coast of North America and the west coast of South America to maximize chances of intercepting every pass of a Vanguard IGY satellite launched from Cape Canaveral and orbiting higher than 300 miles. Like Moonwatch on the optical side, Minitrack had its amateur complement—Project Moonbeam—that enabled amateur radio operators to build simplified tracking stations for about $5,000 using a "Mark II" system also devised by Easton. The Minitrack network itself operated only into the early 1960s.[5]

The Soviet Union's launch of *Sputnik* on October 4, 1957, surprised nearly all American civilian and military space observers, causing them to scramble in the quest for satellite-tracking capabilities. Moonwatch volunteers provided much of the initial orbital information on *Sputnik*, because Baker-Nunn cameras were only then being deployed and Minitrack, which had become minimally operational only a few days earlier, was designed to detect radio signals transmitted by U.S. Vanguard satellites not Soviet Sputniks.[6] By *Sputnik*'s third orbit, however, fewer than five hours after launch, the NRL's radio array at Hybla Valley, Virginia, had begun compiling data on the satellite's orbital track.[7] Within a couple days, sufficient data poured into the Vanguard Computing Center from U.S. Army Signal Research and Development Laboratory receiver equipment at Fort Monmouth, New Jersey, and its experimental sites worldwide to enable determination and prediction of *Sputnik*'s present and future orbits.[8] Meanwhile, the Massachusetts Institute of Technology (MIT) Lincoln Laboratory's Millstone Hill long-range tracking radar, under development as a prototype for the USAF Ballistic Missile Early Warning System (BMEWS), became the first radar to detect signals reflected by *Sputnik* and to track the satellite in range, azimuth, and elevation angle.[9] The Army hastily expanded the Microlock radio-tracking system by moving portable ground stations to San Diego, Cape Canaveral, Singapore, and Nigeria to track Explorer satellites.[10] All this effort made the United States acutely aware of its severely limited, relatively disorganized ability to detect, track, or identify man-made objects in space.

The first organized, full-time attempt at space surveillance originated from Air Force Cambridge Research Center (CRC) efforts in early October

Aerial view of a portion of the Naval Space Surveillance (NAVSPASUR) radar fence.

THE COLD WAR ENVIRONMENT CREATED A SENSE OF URGENCY IN RESOLVING DIFFERENCES OF OPINION WITHIN THE U.S. DEFENSE COMMUNITY; ON THE OTHER HAND, EXTREMELY BITTER INTER-SERVICE RIVALRIES ONLY INTENSIFIED

1957 to track *Sputnik* using four interferometers together with Doppler radar. Led by Milton Greenberg, head of Air Research and Development Command (ARDC) Geophysics Research Directorate, the CRC opened a primitive filter center at Hanscom AFB, Massachusetts, on November 6, 1957. Following a November 18-19 conference at ARDC headquarters, where participants discussed consolidating all ARDC center capabilities for space surveillance, Project Harvest Moon (subsequently called SPACETRACK) became operational at the CRC on November 30. Bringing together electronics, geophysics, computer, communications, astronomical, and mathematical experts in a unified program to predict satellite behavior, the Harvest Moon filter center received satellite-related radar, optical, radio, and other data from various civil and military sources. At the time, only two artificial satellites—*Sputnik* and *Sputnik 2*—orbited Earth.[11]

On January 18, 1958, William M. Holaday, Director of Guided Missiles in the Office of the Secretary of Defense, instructed the Secretary of the Navy to survey existing resources applicable to space tracking and data collection and to draft a plan for coordinated application of all national capabilities to perform the tracking, data collection, and computing required for maximizing knowledge about satellites in the future. Five months later, under Advanced Research Projects Agency (ARPA) sponsorship, a team headed by the NRL's Roger Easton undertook construction of an electronic "fence" composed of transmitters and receivers across the United States from coast to coast. When radio signals transmitted into space bounced off an orbiting satellite, the receivers detected the returning signal. Repeated crossings by the satellite enabled analysts to predict its orbital path with reasonable accuracy, but the more immediate benefit of the system lay in the ability of its operators to notify other surveillance sensors that an object had passed through the fence. The first two stations of that Naval Space Surveillance (NAVSPASUR) system became operational in early August 1958; when fully operational in February 1959, the system included three transmitters and six receivers spread across the southern United States along the 33rd parallel, with control and computation at Dahlgren, Virginia.[12]

Meanwhile, the Air Force dissented in July 1958 when it became clear that a majority of the Satellite Tracking Review Committee, created pursuant to Holaday's instructions earlier that year and chaired by Navy Captain E. M. Gentry, favored operation of the Interim Satellite Detection and Tracking System by an Armed Forces Special Weapons Project-type organization. Richard E. Horner, Air Force Assistant Secretary for Research and Development, informed the ARPA director that both the interim system and its ultimate successor ought to be controlled operationally by the recently established North American Air Defense Command (NORAD). From Horner's Air Force perspective, "detection and identification of the nature of all satellites" was an operational consideration far more important than the research and development (R&D) aspects on which the committee had focused.[13]

Several factors, in addition to the issue of the balance between R&D and operational considerations, affected how long it would take to officially designate a lead organization for space surveillance and which entity that ultimately would be. On one hand, the Cold War environment created a sense of urgency in resolving differences of opinion within the U.S. defense community; on the other hand, extremely bitter inter-service rivalries, only intensified by arguments over who should have what responsibilities for missiles and space systems, predisposed senior officers and civilians in one military department to steadfastly resist, if not outspokenly oppose, the turnover of anything to another department. Since the Air Force and NORAD had responsibility for early warning against a Soviet ICBM attack, however, logic dictated those entities should have primary responsibility when it came to space surveillance. Whether carrying a nuclear warhead or a satellite as its payload, a long-range rocket transited outer space; radar systems designed for early warning also were capable of performing space surveillance, and some space surveillance equipment could provide early warning data. Furthermore, in June 1958, the Air Force issued General Operational Requirement

Ballistic Missile Early Warning System (BMEWS) detection radar, Thule AB, Greenland, early 1960s.

NOT UNTIL MID-AUGUST 1960, HOWEVER, DID THE DECISION-MAKING PROCESS BEGIN TO ACCELERATE, UNDOUBTEDLY PROMPTED BY THE FIRST FULLY SUCCESSFUL, HIGHLY CLASSIFIED CORONA PHOTORECONNAISSANCE SATELLITE MISSION

170 for a satellite defense system, its first phase being space tracking and control and its second anti-satellite weapons. This practically paralleled General Operational Requirement 96, generated three years earlier, for a ballistic missile detection radar system. When it came to defense against attack, however, traditional Army and Navy roles came into play, and those services sought to extend their prerogatives into the new medium of space. Logic and inter-service rivalry came toe to toe.[14]

While ARPA, ARDC, and NRL sought to define military and NASA requirements for the satellite detection and tracking system, and to develop it, the question of an organization to manage it remained unsettled for more than two years. On November 26, 1958, NORAD Commander in Chief General Earle E. Partridge, pursuant to a letter of encouragement from Lieutenant General Roy H. Lynn, USAF vice chief of staff, had asked the Joint Chiefs of Staff (JCS) to give NORAD that responsibility. He cited several operational considerations, foremost among them being to reduce the number of false alarms that satellites generated in the new Ballistic Missile Early Warning System (BMEWS). This required the systematic use of satellite detection and tracking data to continually update files in the planned BMEWS "Satellite Prediction Computer" at the NORAD Combat Operations Center in Colorado Springs. At the end of May 1959, two days after Secretary of Defense Neil H. McElroy asked the JCS to consult with ARPA on assigning operational responsibility for an interim satellite detection system, General Partridge advised the JCS to urge the Secretary of Defense to designate NORAD as operator of the National Space Surveillance Control Center (NSSCC), because that would facilitate positive planning for the rapidly evolving system. Still, decisions about operational responsibilities proceeded glacially, even as actual operations gained momentum.[15]

In March 1960, ARDC voiced concern to HQ USAF that steadily increasing operational aspects of the NSSCC threatened the research and development program and recommended assigning responsibility for the center to NORAD, with ADC as the operating agency beginning in June 1961. Since HQ USAF agreed but said the Secretary of Defense had to decide, ARDC opted to unburden itself of interim operational responsibility by directing its 496L (SPACETRACK) System Program Office to build up within NORAD, as soon as possible, an operational detection and tracking capability. On April 20, Gen. Laurence S. Kuter, who had succeeded General Partridge as CINCNORAD, repeated his predecessor's desire that NORAD receive the space surveillance mission.[16]

Not until mid-August 1960, however, did the decision-making process begin to accelerate, undoubtedly prompted by the first fully successful, highly classified Corona photoreconnaissance satellite mission. Three days after an ad hoc committee of the Air Force Scientific Advisory Board recommended that NORAD gain responsibility for the entire national space surveillance system, Under Secretary of the Air Force Joseph Charyk expressed to Secretary of Defense Thomas S. Gates lingering concern over the lack of a decision in that regard. Charyk believed that establishment of the NSSCC and integration, under USAF management, of all three services' sensors afforded the best path toward initial system capability. One day later, on August 19, although Gates informed the JCS that responsibility for SPACETRACK and NAVSPASUR soon would transfer from ARPA to the appropriate military departments, he requested a recommendation on which existing organization should have overall control of the operational Space Detection and Tracking System (SPADATS). When the service chiefs failed to agree on a recommendation, Gates directed the JCS to assign operational command of SPADATS to Continental Air Command (CONAD) and operational control to

USAF Baker-Nunn space surveillance camera, Edwards AFB, California, September 1968.

IN MARCH 1959, NORAD OFFICIALS ADVOCATED CREATION OF A SPACE ORDER OF BATTLE, ESSENTIALLY A CATALOG OF ALL OBJECTS IN SPACE, AS A FIRST STEP TOWARD AN ACTIVE DEFENSE AGAINST SUCH THREATS

NORAD, which occurred officially on November 7, 1960. Meanwhile, SPACETRACK operations went to ADC, which also functioned as the conduit for collection and transmittal to HQ USAF of all NORAD and CONAD requirements for SPACETRACK and the NSSCC. Finally, on February 9, 1961, USAF Chief of Staff General Thomas D. White directed ADC to assume full technical responsibility for NSSCC operation of SPADATS by July 1.[17]

Although inter-service rivalries and resulting indecisiveness slowed assignment of SPADATS operational responsibilities, development and acquisition of operational capabilities continued to advance. The ARPA-sponsored NRL surveillance program that evolved into NAVSPASUR had begun in June 1958, and ARPA directed ARDC to proceed with the SPACETRACK project, which absorbed Projects Harvest Moon and Shepherd, the latter an alternative to NAVSPASUR for detecting "dark" or passive satellites as they passed over the United States, in December 1958. Sharing the cost, ARPA and ARDC worked to establish requirements, methods, and capabilities for a Space Detection and Surveillance System with an interim NSSCC at Hanscom Field to collect and process data from all tracking sources, maintain an up-to-date catalog of the current space population, research and develop (R&D) analysis and display techniques, and distribute information to various users. During the first two months of 1959, SPACETRACK was designated System 496L, and the Cambridge Research Center purchased five Baker-Nunn cameras to support R&D projects and tracking operations. Around the same time, the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA), which would assume sponsorship of the SAO camera network a few months later, reached a support agreement on global tracking, data acquisition, and communications networking that also acknowledged the importance of a free exchange of information between the Cambridge filter center and the NASA data center.[18]

Locating, tracking, and identifying potentially hostile types of space vehicles concerned NORAD, because someone might use such platforms for reconnaissance or to deliver nuclear warheads.[19] Consequently, in March 1959, NORAD officials advocated creation of a Space Order of Battle, essentially a catalog of all objects in space, as a first step toward an active defense against such threats. Those same officials expressed deep concern about tracking "dark" or non-radiating satellites launched by other countries, because that required different equipment from what was used to track "cooperative" or radiating IGY satellites. Furthermore, detection and tracking of potentially hostile, dark satellites necessitated special communications and computing facilities for rapid processing of raw surveillance data and for quick dissemination of analyses. Such a system demanded maintenance of a catalog to enable both differentiation of

SPADATS-SPACETRACK Operations Center, Ent AFB, Colorado Springs, early 1960s.

"known" objects from newly launched vehicles (not to mention artificial objects from meteors) and rapid prediction of orbits for new vehicles.[20]

When the new NSSCC began operations at Hanscom Field on January 1, 1960, the latest bimonthly satellite situation bulletin reported two dozen objects launched since *Sputnik*, with half of them still in orbit. The computation relied on approximately 800 observations monthly by a "heterogeneous collection of electronic and optical sensors that fed data into a computing facility." That hodgepodge of sensors included NAVSPASUR; various USAF detection and tracking radars, like the AN/FPS-17 at Laredo, Texas, the AN/FPS-49 at Moorestown, New Jersey, and the AN/FPS-43 and 44 on the island of Trinidad; General Electric's Radio-Optical Observatory near Schenectady, New York; the SAO camera network; and Moonwatch teams. Most of the data handling at the sensors and at the computing center was performed manually. Even when the first USAF Baker-Nunn camera, situated near Harestua, Norway, became operational in August 1960 and when the first contingent of USAF personnel arrived at the NSSCC in November to train as space trackers, operations remained rather primitive. Finally, in mid-January 1961, DoD and NASA agreed their general and special-purpose tracking networks would provide trajectory and ephemeris information on U.S. military and scientific satellites, along with whatever was available on foreign spacecraft, to a centralized data collection and cataloging center in the NORAD Combat Operations Center (COC).[21]

NO ORGANIZATION, INCLUDING NORAD, HAD AUTHORITY TO MARSHAL ALL THE SPACE SURVEILLANCE RESOURCES INTO AN INTEGRATED OPERATIONAL SYSTEM

The January 1961 DoD-NASA agreement, which provided for DoD disseminating catalog data to NASA, came after the Joint Chiefs of Staff reneged somewhat on the original 1959 support agreement by deciding to no longer share SPACETRACK data with NASA. That decision came in the immediate wake of the first successful Corona reconnaissance satellite missions and a perception on the part of DoD officials that precise orbital information about those satellites should be protected. Henceforth, a DoD-NASA Aeronautics and Astronautics Coordinating Board (AACB), created on September 13, 1960, provided a channel for military screening of catalog data for sensitive information that NASA otherwise might pass inadvertently. The formal DoD-NASA agreement stated, "In some instances, security considerations may dictate the withholding of specific items for limited time periods." When NASA issued its first "Satellite Situation Report" under the restrictive agreement on February 17, 1961, complaints arose almost immediately and drew congressional criticism.[22]

As previously directed by General White, ADC at Ent AFB in Colorado Springs assumed full technical responsibility for NSSCC operation of SPADATS by July 1961. The command procured the computer industry's first transistorized model, a high-speed Philco 2000, plus some IBM peripheral equipment. Organizationally, ADC activated the 1st Aerospace Surveillance and Control Squadron to operate both the SPADATS Center (i.e., a name change, with NORAD concurrence, from NSSCC) and the BMEWS Central Computer and Display Facility in the NORAD COC, which featured a computer system—the Display Information Processor—custom built by Radio Corporation of America (RCA). Lieutenant General Robert M. Lee, ADC commander, explained, "SPADATS, with developed improvements, will be the key to control of space." Even before June 12, 1961, when the SPADATS Center at Ent assumed operational functions previously conducted by the NSSCC at Hanscom, ADC pressed for improvements that would better satisfy military requirements: direct input from radars in Turkey; transfer of the mechanical tracker and detection fan on Shemya to ADC; integration of BMEWS and SPADATS; and design and fabrication of a phased-array radar specifically dedicated to space surveillance (i.e., the AN/FPS-85 at Eglin AFB, Florida).[23]

By late summer 1961, SPADATS operation remained dependent on participation from many different sensors operated by various military and civilian organizations, principally for purposes other than space surveillance. No single element could perform the total mission, and most relied on beacon tracking with little detection capability. No organization, including NORAD, had authority to marshal all the space surveillance resources into an integrated operational system. Informal agreements, personal cooperation, and outright bootlegging characterized the methodology behind what had been accomplished thus far. High cost projections and long lead times for developing and deploying the "SPADATS-Improved" envisioned by CINCNORAD left future capabilities uncertain, even as the number of satellites in orbit continued to grow.[24]

With forty-six active satellites and a total of 225 man-made objects in the space catalog in early December 1962, plus an official task from DoD Director for Defense Research and Engineering

Space Defense Center inside the Cheyenne Mountain Complex near Colorado Springs, Colorado, 1973.

(DDR&E) Dr. Harold Brown to survey the first-orbit detection capability of existing sensors, the USAF pointed out that SPADATS needed considerable improvement. The existing system, still heavily dependent on development equipment never intended for operational use, could not predict a satellite's location with sufficient accuracy to satisfy anticipated requirements. Radars lacked the desired range and resolution, and deployed sensors could not detect or track objects in all orbits or inclinations. Precise geodetic locations for individual sensors remained a mystery, and Earth's gravitational effects on orbiting objects were unknown, although persistent on-site improvements by Dr. Louis G. Walters of Ford Aerospace Corporation gradually would produce much higher accuracy. At the same time, no programmatic plans existed for overcoming deficiencies in the system.[25]

BY YEAR'S END, AN AGGRESSIVE PROGRAM TO COLLECT SIGNATURE DATA ON VARIOUS KINDS OF SOVIET SPACECRAFT WAS UNDERWAY AT THE SPADATS CENTER

By this time, the SPADATS Center functioned according to an established routine. It collected positional data from participating sensors at 100 words per minute via a teletype network. That information went into a computer programmed with sophisticated computational routines for near-earth and interplanetary orbits to initially define the new object's orbital elements. Further observations helped refine those orbital elements, which then entered the NORAD master catalog of all man-made space objects. Those element sets, usually maintained with sufficient accuracy to permit reliable positional predictions on average up to thirty days, enabled system sensors to reacquire each object periodically throughout that object's on-orbit lifespan.[26]

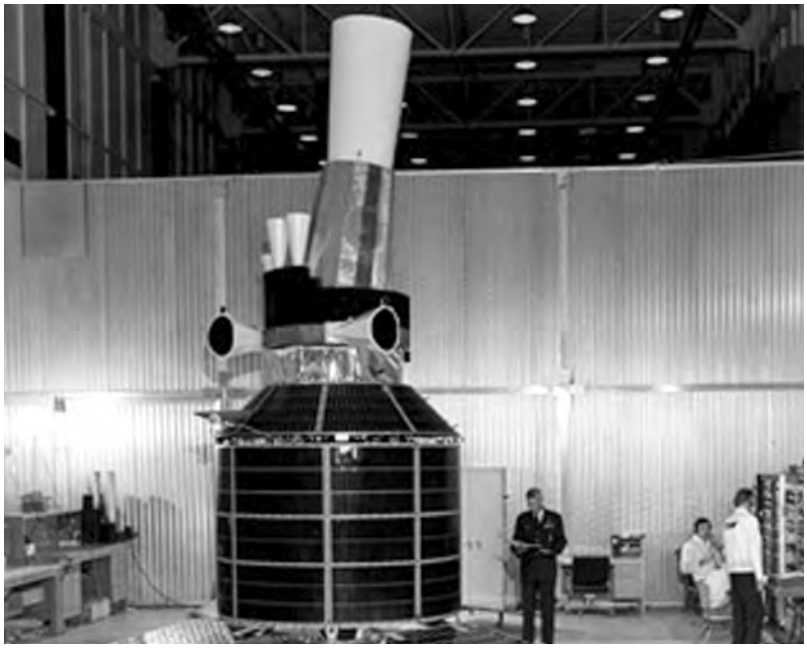
During 1963, the challenge of identifying the type or purpose of man-made space objects received heightened attention. In April, the USAF sent the first personnel to Space Object Identification (SOI) courses conducted by RCA at Cherry Hill, New Jersey. By year's end, an aggressive program to collect signature data on various kinds of Soviet spacecraft was underway at the SPADATS Center. This effort, combined with new techniques that included computer-assisted interpretation and reduction of data from various kinds of sensors positioned around the globe, improved analysts' ability to estimate the operational mission of any particular object the Soviet Union launched.[27]

Phase Two (1964-1971)

If the half dozen years after the launch of *Sputnik* constituted an initial phase in the development of a national space surveillance system, a second phase occurred during 1964-1971. Further upgrades to computational capabilities and to existing ground-based sensors occurred to meet more demanding requirements. In May 1964, for example, the USAF deployed an operational anti-satellite (ASAT) system—Program 437—pursuant to DoD direction. Consequently, the service needed quicker, more accurate orbital determination and identification of potentially threatening objects—e.g., reconnaissance satellites or multiple orbital bombardment satellites (MOBS)—launched from the Soviet Union.[28] Another requirement that placed significant demands on the surveillance network involved accurate prediction of impact points for reentering space objects. This was required initially for owners of U.S. spacecraft but, subsequently, was formalized in the 1967 Outer Space Treaty, which made countries responsible for damages resulting from anything they launched into space that reentered and impacted another country.[29]

In addition to those more demanding requirements, the second phase involved moving the entire NORAD Combat Operations Center, including the manually operated SPACETRACK/ SPADATS Center, from Ent AFB into a new, hardened facility deep inside Cheyenne Mountain southwest of Colorado Springs. The Cheyenne Mountain Task Force, appointed by Secretary of Defense Robert McNamara, recommended in March 1964 that all space-defense activities—i.e., System 496L—be separated from command-and-control (C2) tasks—i.e., System 425L—and performed in a new semi-automatic computer-operated facility called the Space Defense Center (SDC). When the SDC became operational in the Cheyenne Mountain Complex (CMC) on February 6, 1967, ADC and NORAD gained a faster flow of information on the more than 1,000 orbiting objects then in the space catalog. An upgrade of command, control, and communications from the SDC to various sensor sites also occurred.[30]

More powerful software took into account additional variables, such as atmospheric drag and gravitational forces as functions of latitude and longitude. A Spiral Decay computer program, designed by Aeronutronic Systems, Inc. cofounder Louis G. Walters' team and introduced in 1964 for reentry processing, assigned weights and biases to data from SSN sensors and performed a differential correction to more accurately predict the position and



First Defense Support Program (DSP) satellite in assembly facility, 1970.

velocity of objects affected by high atmospheric drag. The new "Delta" computer system in the SDC also provided capabilities for real-time interrupts for new foreign launches and for automatic sequencing routines. Despite these improvements, senior military officials perceived the continued inability of SPADATS to detect all Soviet space objects on the first orbit as posing a grave risk.[31]

From 1967 through the remainder of the decade, despite a decrease in the total number of space launches worldwide, the number of man-made objects in space that required identification and cataloging grew exponentially from around 1,200 to more than 2,400. Although primarily due to improved sensing and computing capabilities, the numerical increase in cataloged objects also reflected the military desire for a more complete understanding of potential space-related threats. If the need for greater accuracy to support ASAT and impact-prediction responsibilities was not sufficiently demanding, emergence of the Sentinel and Safeguard anti-ballistic missile (ABM) systems created a further need for SPADATS information to purge the ABM tracking system of known satellites and to prevent the possibility of a false attack warning.[32]

FROM 1967 THROUGH THE REMAINDER OF THE DECADE,… THE NUMBER OF MAN-MADE OBJECTS IN SPACE… GREW EXPONENTIALLY FROM AROUND 1,200 TO MORE THAN 2,400

The SPADATS network sensors evolved and expanded during 1964-1971. Relocation of two Baker-Nunn cameras, one from Chile to Mt. John Observatory near Christchurch, New Zealand, and the other from Norway to San Vito, Italy, improved optical tracking. Furthermore, the entire Baker-Nunn system underwent a technical enhancement that reduced from twenty-four hours to twelve the time to search, find, compile an accurate observation, and report it to the SDC for more timely orbital analysis.[33] Despite a major setback in January 1965, when fire destroyed the transmitter and receiver antenna faces during acceptance testing of the AN/FPS-85 phased-array radar at Eglin AFB, Florida, the network eventually gained its first radar designed expressly for space surveillance. After extensive rebuilding, the FPS-85 radar began SPACETRACK operations on January 29, 1969, and almost immediately, it autonomously discovered many new, small objects (usually debris related to launches from years past) for addition to the catalog. Because of its relatively lower latitude, the FPS-85 radar allowed the network to pick up low-inclination satellites and greatly increased the overall capacity of the surveillance system. It could track simultaneously 200 known objects or twenty "unknowns" compared to earlier sensors that tracked a single object. Its computational capability earned the Eglin radar site designation as the alternate SDC.[34] The USAF also began experimenting with RCA's AN/FSR-2 "optical radar" at Cloudcroft, New Mexico, and an improved system atop Mount Haleakala on Maui, Hawaii, to obtain a satellite's "optical signature" instead of its photographic image.[35]

Phase Three (1971-1998)

A third phase in SPADATS network evolution became apparent in 1971, largely due to launch of U.S. Defense Support Program (DSP) infrared-detecting satellites and in response to a perceived Soviet ASAT threat. Timely warning and verification of an attack against U.S. or other friendly satellites became imperative, because the Soviet Union had conducted its first successful test of a complete co-orbital ASAT in October 1967 and performed a series of successful tests against a hardened target satellite in 1971.[36] At the same time, the United States had begun phasing out Program 437 nuclear ASAT capability, thereby relinquishing its ability to respond in kind to a Soviet attack on a low-orbiting satellite and, in the eyes of some defense specialists, inviting the Russians to become more aggressive.[37] In the mid-1980s, developmental testing of a U.S. air-launched ASAT system demanded extremely accurate tracking data to ensure successful interception of target satellites. Although deployed to provide early warning of a Soviet nuclear missile attack against North America by detecting missiles in their boost phase, it soon became obvious that DSP also supplied more timely data to SPACETRACK. Instead of the twenty to thirty minutes previously required to determine the purpose of a launch—i.e., long-range missile test or space lift—DSP satellites orbiting at geosynchronous altitude permitted such a determination in as little as one-tenth the time.[38]

As for ground-based sensors, a number of upgrades and additions significantly enhanced the space surveillance network during the 1970s. The Perimeter Acquisition and Attack Characterization System (PARCS), originally built at Concrete, North Dakota, for the Safeguard ABM system and designed for precise tracking of small objects reentering the atmosphere, joined the SPADATS network in 1974. Three years later, the AN/FPS-108 Cobra Dane phased-array radar replaced the

(Above) Diego Garcia GEODSS site in the Indian Ocean, ca. 1990.

(Right) Ground-based Electro-Optical Deep Space Surveillance (GEODSS) camera.

mechanical tracker and detection fan on Shemya, which greatly increased the number of objects it could track simultaneously and, furthermore, extended the range for detection and tracking of Soviet launches. In 1978, addition of the Maui Optical Tracking and Identification Facility (MOTIF) advanced the network's optical capability over Baker-Nunn by providing near-real-time observations on satellites in deep space—those with an orbital period greater than or equal to 225 minutes. Finally, in 1980, the AN/FPS-115 PAVE PAWS radars at Cape Cod AFS in Massachusetts and Beale AFB in California, although employed primarily for detection of submarine-launched ballistic missile launches, began furnishing highly precise detection and tracking of satellites.[39]

THE USAF BEGAN OPERATING ITS GROUND-BASED ELECTRO-OPTICAL DEEP SPACE SURVEILLANCE SYSTEM (GEODSS) TO SUPPLEMENT AND, ULTIMATELY, TO REPLACE BAKER-NUNN CAMERAS

The 1980s witnessed further expansion and improvement of network sensors. To better cover the increasing number of objects in deep space, the USAF began operating its Ground-Based Electro-Optical Deep Space Surveillance System (GEODSS) to supplement and, ultimately, to replace Baker-Nunn cameras. To improve early detection of Soviet space launches and determine orbital elements more accurately, the service deployed a series of mechanical tracking radars across the South Pacific in what became known as the Pacific Barrier (PACBAR) system. Using data from the Navy's Transit satellites to recalibrate various existing radars, the Improved Radar Calibration Sensor Program resulted in more accurate positioning data on new launches. Upgrades to contributing mechanical radars on Kwajalein and at Diyarbakir in Turkey enabled geosynchronous satellite tracking. At the very end of the decade, Air Force Space Command began deploying passive radio-frequency (RF) sensor systems—the Deep Space Tracking System (DSTS) and the Low-Altitude Space Surveillance System (LASS). Altogether, those initiatives significantly increased the amount of data available to analysts at the central processing facility, where assessing potential threats and maintaining the space catalog were increasingly crucial.[40]

Meanwhile, to improve command and control (C2) of space surveillance operations, the Space Defense Operations Center (SPADOC) replaced the SDC in Cheyenne Mountain during October 1979. The establishment of SPADOC came with recognition of USAF responsibilities for satellite protection—i.e., the need for advisory warning to U.S. and other friendly satellite owners or operators of any hostile threat to their systems and to supply collision-avoidance information. In the mid-1980s, SPADOC also played a key C2 role in the air-launched ASAT test program. A merger of the Space Surveillance Center and SPADOC in 1994 resulted in a Space Control Center (SCC). Through most of the 1990s, a major effort known as SPADOC-4 reduced many functions still being performed manually; it automated the correlation of large quantities of intelligence and operational data to meet short timelines for supplying orbital information. The SPADOC incorporated Special Perturbations (SP) ephemeris, which led to an Omitron Corporation team headed by William N. Barker introducing SPECTR software for more accurate orbit determination and prediction. This software ran on the Astrodynamics Support Workstation (ASW) that became operational in 1998. It supported NASA International Space Station (ISS) operations by maintaining a subset of the space catalog—about 700 satellites that posed a collision threat to the ISS.[41]

As the end of the twentieth century approached, a host of factors on earth and in outer space reconditioned how military, civil, and commercial owners or operators of satellite systems perceived, even defined, space surveillance. Increasingly, people worldwide understood how much they depended daily on space-based services. Proliferation of commercial satellite systems, mostly for communications and remote sensing, sparked discussions about their need for the same kinds of protection that nations accorded their commercial vessels at sea. The number of countries and other entities owning operational satellites began to grow markedly, especially with the advent of relatively inexpensive micro-satellites, many with dual-use capabilities that could satisfy both civil and military requirements.[42] Perhaps the best known dual-use system became the U.S. military's

Global Positioning System (GPS), which officially achieved full operational status in April 1995 and became widely acknowledged as an essential global utility for highly accurate positioning, navigation, and timing. Another factor, certainly one of the most worrisome, was the accumulation of orbital debris—rocket bodies, dead spacecraft, fragments from explosions or collisions, and other so-called "space junk"—that posed a threat to the growing number of active satellites, piloted spacecraft like the Shuttle, and platforms like the Russian *Mir* and the *International Space Station*.[43]

MILITARY STRATEGISTS REVITALIZED THE CONCEPTS OF "SPACE CONTROL" AND "SPACE SUPERIORITY" THAT SOME VISIONARIES HAD EXPRESSED EVEN BEFORE THE LAUNCH OF THE WORLD'S FIRST ARTIFICIAL SATELLITE

Naturally occurring objects also posed a threat, both to active satellites and to the earth itself. Consequently, a cooperative effort between the Jet Propulsion Laboratory/NASA and AFSPC began in December 1995 to study earth-crossing asteroids and comets. This Near-Earth Asteroid Tracking (NEAT) project aimed to detect, track, and catalog natural objects that potentially could collide with the earth or interfere with satellite operations. The team relied first on the Maui 1-meter GEODSS telescope, which continued making NEAT observations until mid-February 1999. NEAT operations at Maui recommenced in January 2000 using the AMOS 1.2-meter telescope and, in April 2001, the 1.2-meter Samuel Oschin telescope at Palomar Observatory joined the endeavor.[44]

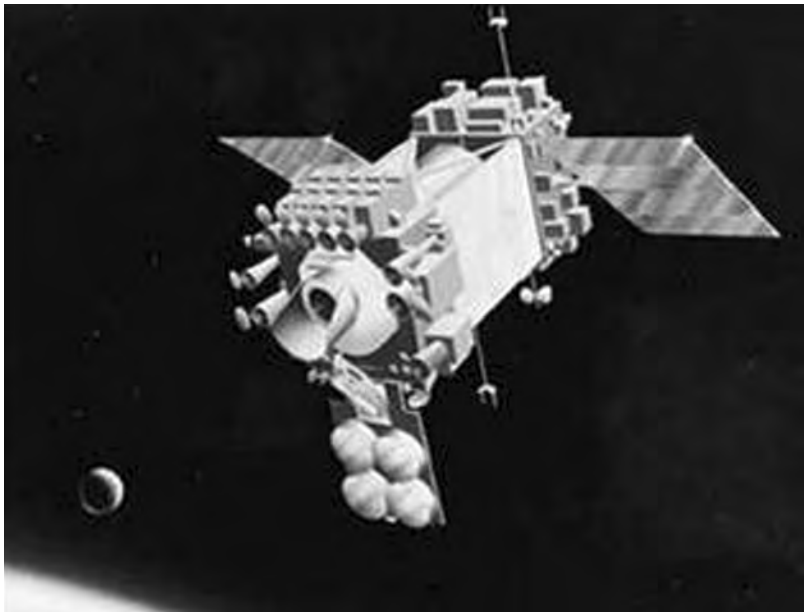
Meanwhile, the Air Force Research Laboratory began developing a 16-inch Raven telescope system, which used commercially available components to lower acquisition, operation, and maintenance costs. The Raven program evolved from an investigation of using small-diameter (i.e., less than 0.5 m) telescopes for automated follow-up observations of asteroids discovered by the NEAT or other search projects. Although these instruments proved unsatisfactory for seeing very dim NEAT objects, they were ideal for routine, very low-cost, high-quality surveillance of cataloged satellites in deep space, thereby reducing the load on more capable telescopes and freeing the latter to perform more demanding observations. One expert suggested that placing about thirty Raven scopes atop U.S. embassies or consulates around the globe would cost roughly $10 million in the near term compared to several billion dollars for a space-based space surveillance system.[45]

Political and defense-related considerations further complicated the need for understanding what was occurring to, or around, U.S. and other on-orbit spacecraft. In Operation Desert Storm during early 1991, a coalition of forces led by the United States drove Saddam Hussein's Iraqi military out of Kuwait and, in the process, used satellite systems so extensively as to earn the sobriquet "the first space war." Later that same year, the Soviet Union collapsed, bringing an end to the decades-old Cold War. A new nemesis began to emerge in the form of global terrorism, even as the Chinese caused consternation by expanding their space-related activities. As the United States attempted to resolve conflicts, even to end genocide, by intervening militarily in places like Bosnia and Kosovo, the reliance of all its forces on satellite communications and the demonstrated effectiveness of GPS-guided munitions caused military strategists to ponder with heightened concern the consequences of interference with U.S. space systems. This became a critical issue as satellites designed primarily for strategic purposes became increasingly integral to successful theater or tactical war fighting and increasingly vulnerable, at least potentially, to enemy attacks.

Anticipated changes in requirements also affected planning for a fourth phase of surveillance network development. In the early 1980s, USAF experts already had perceived the current system, designed for peacetime operations and dependent on overseas sensors, would not "remain viable through an attack, after the attack, through another attack, for some unspecified length of time" without extraordinary alterations. Although they cautioned against automatically assuming that space-based systems could be made more survivable than terrestrial systems, they extolled that possibility. Furthermore, surveillance specialists worried that the existing network was designed for detection and periodic tracking of satellites in relatively predictable orbits affected only by such natural forces as gravitational variance, atmospheric drag, and solar radiation pressure. They argued that existing capabilities made it extremely difficult, if not impossible, to keep track of satellites capable of orbital maneuvering, particularly those moving from one plane to another. Since space-based space surveillance (SBSS) offered the prospect of nearly continuous, comprehensive observation, it seemed to be the best way to keep track of maneuvering satellites over their orbital lifetime. The rapidly increasing number of man-made objects, whether in "natural" orbits or unpredictable ones, also heightened the need for the "reliable and enduring worldwide coverage of space objects at all altitudes" that SBSS offered.[46]

Phase Four: 1998-Present

With all these factors or conditions in mind, military strategists revitalized the concepts of "space control" and "space superiority" that some visionaries had expressed even before the launch of the world's first artificial satellite.[47] Space surveillance became widely acknowledged as the fundamental key to achievement of space control and, as such, theorists began to reconstruct its meaning in a broader sense. A report from the USAF Scientific Advisory Board (SAB) in June 1997, anticipating the emergence of space-control requirements, recommended improvements to the accuracy and responsiveness of space surveillance.[48] The *Long Range Plan* presented by General Howell M. Estes III, United States Space Command commander in chief, in March 1998 not only touted space surveillance as "the foundation for space superiority" but added, "Near real-time space situational awareness, enabled by Surveillance of Space is the key contributor to the Control of Space and enabling



MSX satellite with Space Based Visible (SBV) sensor provided space-based space surveillance data, 1998-2008.

freedom of operations within it."[49] A new term—"space situational awareness" or SSA—had entered the lexicon.[50]

Essentially, SSA amounted to sufficient current and predictive knowledge—gained through space surveillance, space-related intelligence and reconnaissance, and space environmental monitoring—about "conditions, constraints, capabilities, and activities…in, from, toward, or through space" to enable, first, discernment of an adversary's intentions and, second, development of effective counterspace courses of action, either defensive or offensive.[51] The January 2001 report of the congressionally mandated Commission to Assess United States National Security Space Management and Organization, chaired by soon-to-be Secretary of Defense Donald Rumsfeld, called for improving SSA to avoid a "Space Pearl Harbor." Nine months later, the *Quadrennial Defense Review Report* noted the United States would "pursue modernization of the aging space surveillance infrastructure, enhance the command and control structure, and evolve the system from a cataloging and tracking capability to a system providing space situational awareness."[52] To promote coordinated, cost-effective evolution toward SSA, the Secretary of the Air Force directed the AFSPC commander to create a Space Situational Awareness Integration Office in early 2002.[53]

SECRETARY OF DEFENSE DONALD RUMSFELD, CALLED FOR IMPROVING SSA TO AVOID A "SPACE PEARL HARBOR"

By then, pursuant to the 1997 SAB recommendations and to satisfy specific NASA and NRO requirements, an effort led during 1998-1999 by Wilbert F. "Bill" Craig III, a mathematician whose intimate association with satellite tracking began when he joined the Air Force SPACETRACK team in 1961 and who oversaw many of the significant system improvements during the next 35 years, used the ASW and its SPECTR software to test the High Accuracy Catalog (HAC) concept. Using only data from sensors tasked by the Space Control Center to maintain the general or standard catalog, but employing Special Perturbation (SP) algorithms and covariance matrices recommended in the SAB report, the HAC or special catalog became fully operational in Cheyenne Mountain in September 1999. Both catalogs contained data on all objects being tracked by the surveillance network, but the special catalog provided sharper awareness of foreign satellites that at any particular time might have high national-security interest.

Furthermore, it allowed more accurate orbital predictions for potentially hazardous debris at the lower altitudes of human spaceflight. The general catalog remained available to users of the Integrated Tactical Warning and Attack Assessment (ITW&AA) system and to others via NASA's Orbital Information Group (OIG) website; information from the special catalog went only to selected users on a case-by-case basis. Several times more accurate than the general catalog, the HAC represented the most significant advancement in space cataloging since the late 1950s.[54]

To enable even better orbital predictions, work also commenced in the late 1990s to improve modeling of atmospheric density. This effort focused on using the observed drag effects on low-perigee, inactive payloads and debris for calculation of atmospheric-density variations in near-real time. An Omitron team headed by Stephen J. Casali, and working through the AFSPC Space Battlelab, developed a Dynamic Calibration Atmosphere (DCA) algorithm to account for diurnal and semidiurnal variations in density of the upper atmosphere. Aided by Bruce R. Bowman's team from the AFSPC Space Analysis Center (HQ AFSPC/A9AC), this effort evolved into the High Accuracy Satellite Density Model (HASDM) project. After undergoing peer review and operational testing in 2002-2003, the first phase of HASDM/DCA—essentially HAC's atmosphere—became operational in Cheyenne Mountain in 2004, thereby enabling extremely accurate predictions for satellites orbiting at or below 800 kilometers. From that initial phase, which relied on eighty satellites for calibration, HASDM entered a second phase—Sapphire Dragon—that used 140 satellites for calibration. Sapphire Dragon yielded highly accurate orbital predictions for three-day periods. In June 2007, a third HASDM phase—Fiery Dragon—sought to use even more satellites and to extend highly accurate predictions outward to seven days. The HASDM/DCA amounted to an evolutionary replacement for the comparatively static atmospheric-density model used by the SPADOC system.[55]

From a sensor perspective, space-based space surveillance (SBSS) offered one avenue toward realization of improved SSA. The SBSS program originated from conceptual studies begun during the early 1970s, when it became obvious that the number of man-made objects in deep space would increase dramatically over the next twenty years. Formal initiation of an SBSS program occurred in Fiscal Year 1976. As the Air Force neared completion of an SBSS Request for Proposal (RFP), how-

ever, a critical Air Force Audit Agency report in November 1983 and establishment of the Strategic Defense Initiative (SDI) program in January 1984 resulted in a March 28, 1984, decision to defer acquisition of the SBSS system. Despite this setback, the need remained for an SBSS capability to enhance deep-space tracking. Admittedly, an SBSS system could complement ground-based radars and optical sensors by providing an alternative phenomenology for detection of objects against the cold background of space. The existing network of ground-based sensors performed near-space surveillance well, but it inadequately addressed deep-space surveillance in general and, in particular, left a serious gap in coverage of the geosynchronous belt over the eastern hemisphere. An SBSS system could improve deep-space surveillance overall, and could cover the eastern-hemisphere gap in particular.[56]

ESTABLISHMENT OF THE STRATEGIC DEFENSE INITIATIVE (SDI) PROGRAM IN JANUARY 1984 RESULTED IN A MARCH 28, 1984, DECISION TO DEFER ACQUISITION OF THE SBSS SYSTEM

Launch from Vandenberg AFB, California, of the Ballistic Missile Defense Organization (BMDO) *Midcourse Space Experiment* (MSX) satellite, with its Space-Based Visible (SBV) optical sensor, on April 24, 1996, resurrected AFSPC's prospects for a near-term SBSS capability. The SBV flight sensor project had begun at MIT's Lincoln Laboratory in 1989 and, during the first eighteen months on orbit, a variety of experiments conducted by the BMDO Space Surveillance Principle Investigator team demonstrated the possibility that MSX/SBV might serve as a highly productive asset in the Space Surveillance Network (SSN). Consequently, efforts commenced in October 1997 to transition the SBV sensor from its experimental status into an SSN contributing sensor. The transition occurred as part of AFSPC's first OSD-approved Advanced Concept Technology Demonstration (ACTD)—SBSS Operations (SBSSO). On May 13, 1998, the SBV sensor completed its trial period and attained fully operational status as an SSN contributing sensor. By then, it provided an average of 100 tracks daily on deep-space objects.[57]

Per DoD direction, BMDO transferred control authority over the MSX satellite to AFSPC on October 1, 2000. This allowed the command to transition MSX/SBV further into AFSPC operations as a dedicated SSN sensor. By then, the satellite was contributing over 1,500 observations daily to the SSN, which enabled AFSPC "to locate objects in key deep-space orbits every 2.5 days, compared with five days when using only ground-based systems." This helped reduce the list of "lost" satellites by eighty percent. Consequently, in September 2002, the USAF decided to acquire a full-fledged SBSS system and contracted, in March 2004, with a Boeing-Ball Aerospace team to develop and initially operate it. The industry team bore responsibility for delivering a single "pathfinder" satellite and ground segment that would pave the way toward a full on-orbit constellation. Although AFSPC did not plan to launch the SBSS pathfinder satellite until early 2009, it decommissioned the MSX on June 2, 2008, because the SBV sensor had degraded to the point of being unreliable.[58]

A new X-band, mechanical radar for tracking and imaging objects in deep space also became operational at a test site on Vandenberg AFB, California, in 1996. The AN/FPS-129 radar, sporting a 27-meter dish and using specialized waveforms, delivered sensitivity and metric accuracy that exceeded the capabilities of all previously existing U.S. Air Force surveillance radars. Built by Raytheon Electronic Systems and dubbed HAVE STARE, the AN/FPS-129 could detect objects in the 1 to 10-centimeter range out to a distance of 40,000 to 45,000 kilometers. Moved from Vandenberg AFB to its final operating location near Vardø, Norway, during October 1998-May 1999 and renamed Globus II, the AN/FPS-129 underwent a lengthy trial period before rejoining the SSN as a dedicated sensor.[59]

Several other SSA-related initiatives, some with more longevity than others, emerged during the first decade of the twenty-first century. Originating from a 1995 "Geosynchronous Imaging Experiment" analytical study and a 1999 "Space-Based Deep Space Imager" idea, the concept of an Orbital Deep-Space Imager (ODSI) emerged in 2004. Unlike the low-earth-orbiting SBSS, ODSI would enter a high-altitude orbit and be allowed to "drift," approach deep-space satellites without maneuvering, and obtain high-resolution images of them. Funding priorities, however, forced cancellation of ODSI only a few months after the February 2005 contract award for a concept study.[60]

The Air Force Research Laboratory, in April 2004, awarded Trex Enterprises Corporation of San Diego, California, a contract for development of a Satellite Active Imaging National Testbed (SAINT). Using Fourier telescopy as the basis for a new ground-based surveillance system, the USAF planned to demonstrate within five years that SAINT could image objects in low-earth orbit, then improve its capabilities to achieve geosynchronous observations within fifteen years. Like ODSI, however, SAINT became the victim of higher funding priorities in the Fiscal Year 2008 budget request.[61]

In August 2007, Defense Advanced Research Projects Agency (DARPA) program manager Roger Hall reported progress on development and demonstration of two new, ground-based systems—Space Surveillance Telescope (SST) and Deep View—for detecting, tracking, and identifying small, dimly lit objects in deep-space orbits. The SST, a 3.5-meter optical device with a large, curved focal-plane array, combined "high detection sensitivity, short focal length, wide field of view, and rapid step-and-settle to provide orders of magnitude improvements in…detection of un-cued objects in deep space for purposes such as asteroid detection and space defense missions." To help identify faint objects (e.g., microsatellites) and determine their status, the Deep View program upgraded MIT Lincoln Laboratory's Haystack Radar facility in Tyngsborough, Massachusetts, from X-band (9.5-10.5 GHz) to W-band (92-100 GHz) for order-of-magnitude improvement in imaging resolution.[62]

In addition to pursuing new space-based and

NAVSPASUR receiving site, San Diego, California, 1993. *(Photo by T. Kneisel)*

ground-based sensors, the USAF sought to improve existing systems. Eglin's AN/FPS-85 system received a new radar-control computer in 1994 and a new software package in 1999. These changes allowed it to detect smaller-size debris objects at human-spaceflight altitudes.[63] The GEODSS Modification Program, which included new mission-critical computer resources and reconfiguration of the entire system to permit dynamic scheduling in near-real time, became operational on August 3, 1999. The following year, replacement of GEODSS outdated Ebsicon analog video cameras with state-of-the-art, highly sensitive digital cameras using Charge-Coupled Device (CCD) arrays commenced under the five-year DEEP STARE program. Those upgrades significantly improved the metric accuracy, throughput, and sensitivity of the system.[64]

"ADVANCING SURVEILLANCE" … REQUIRED NEW GROUND- AND SPACE-BASED OPERATIONAL CAPABILITIES THAT BRIDGED BETWEEN SURVEILLANCE AND DEFENSIVE COUNTER SPACE

Meanwhile, in 2003, the Navy began transitioning operational control of its aging AN/FPS-133 NAVSPASUR interferometric detection fence—three transmitters and six receivers located across the United States along the 33rd parallel—and the Alternate Space Control Center at Dahlgren, Virginia, to AFSPC. After the official transfer ceremony on October 1, 2004, the NAVSPASUR fence became known as the Air Force Space Surveillance System (AFSSS), which AFSPC planned to convert from a very high frequency (VHF) system to S-band. That conversion, scheduled for completion sometime after 2013 depending on funds, would improve measurably the AFSSS detection threshold. From finding basketball-size objects at 15,000 nautical miles, AFSSS detection capability would improve to finding golf ball-size objects at a similar range.[65]

All these upgrades, nonetheless, remained in the traditional realm of detecting, tracking, identifying, and cataloging man-made objects in outer space. Advancing surveillance to a truly different level, one where warfighters could become more aware of environmental or emerging man-made threats to critical U.S. space assets, required new ground- and space-based operational capabilities that bridged between surveillance and Defensive Counter Space. By 2007, the USAF had already prototyped a Rapid Attack Identification, Detection and Response System (RAIDRS) and envisioned an incremental approach to its full implementation, which would employ on-orbit sensors to differentiate among man-made threats, intentional attacks, unintended encounters, and natural events that affected DoD satellites.[66]

Military planners contemplated several different concepts for on-orbit sensing to support RAIDRS. One harkened back to the Satellite Interceptor (SAINT) for which the USAF had issued a requirement in June 1958. It involved orbital maneuvering to rendezvous with a target, examine the suspicious craft up close to determine whether it posed a threat, and take defensive measures as necessary to protect U.S. satellites. In the late 1990s, AFRL revived this idea with an Experimental Spacecraft System (XSS) Microsatellite Demonstration Project and, in 2003, successfully used the XSS-10 satellite to approach an orbiting Delta II second stage, maneuver around it, and transmit video imagery live to analysts on the ground. The XSS-11 in 2004 and Orbital Express in 2007 further demonstrated the potential for microsatellites to perform inspection and other functions in close proximity to another on-orbit object.[67]

Building on the XSS experience, AFRL began seeking information in 2005 for a program called Autonomous Nanosatellite Guardian for Evaluating Local Space (ANGELS). This program aimed for launching a very small satellite into geosynchronous orbit to escort a larger satellite, monitoring the space around that host satellite, and warning of intruders or threats.[68] Under a different program dubbed Self-Aware Space Situational Awareness (SASSA), which Under Secretary of the Air Force Ronald M. Sega vigorously advocated, the USAF would develop "a suite of sensors in the visible through the RF spectrum" that would reside on a satellite's bus to detect, locate, and report threats to the satellite's health.[69]

If SSA was necessary to protect America's military and national security assets in space, distribution of basic information from the space catalog to a wide variety of commercial and foreign entities (CFE) also became increasingly critical. Interference, intentional or otherwise, by one party with another's satellite could cause degradation in service, destruction of an on-orbit asset, or international conflict. Although the U.S. Space Surveillance Network originated for essentially military purposes, other government, commercial, and foreign entities had relied almost exclusively since the early 1960s on information it released to reduce the risk of their spacecraft colliding with other objects orbiting Earth. At the end of the twentieth century, the U.S. military, in accordance with the January 1961 DoD-NASA support agreement, sent an unclassified portion of its processed surveillance data to NASA, which made the information available to other non-military users. On January 10, 2000, however, a DoD memorandum directed the USAF to study, in coordination with the other military services and space agencies, alternatives for providing space-surveillance support to CFE.[70]

THE CFE PILOT PROGRAM, SCHEDULED TO RUN FROM MAY 22, 2004, TO MAY 21, 2007, INVOLVED A THREE-PHASE TRANSITION OF RESPONSIBILITIES FROM NASA TO AFSPC

By June 2002, AFSPC was proposing a pilot study to replace the existing NASA arrangement with one using a Federally Funded Research and Development Center (FFRDC). Approval to proceed with the study depended on resolution of data-control issues, DoD approval, and enactment of authorizing legislation to make dissemination of space-surveillance data to CFE part of the AFSPC mission. Section 913 of Public Law 108-136 (The National Defense Authorization Act for Fiscal Year 2004), signed on November 24, 2003, stipulated the AFSPC pilot program should commence "not later than 180 days" from that date or by May 22, 2004. Lt. Col. David M. Maloney, HQ AFSPC chief of space situational awareness (XOCS), noted in a public announcement that implementation of the pilot program involved receiving delegation of authority from the Secretary of Defense and transferring as many as 1,115 currently active user accounts from the NASA Orbital Information Group (OIG) website to the new CFE Space-Track website. Furthermore, Maloney explained it would take several months to provide "the same latency" or "functionality" that the OIG website had provided for many years.[71]

The CFE pilot program, scheduled to run from May 22, 2004, to May 21, 2007, involved a three-phase transition of responsibilities from NASA to AFSPC. In phase one, the CFE Support Office (CSO), operated by The Aerospace Corporation under oversight from the HQ AFSPC operations directorate, would begin developing the Space-Track website that, ultimately, would replace the NASA OIG website. Plans called for a ninety-day transition period during which the CSO would continue adding functionality to fully replicate OIG capabilities, while NASA would advertise termination of its website and encourage its OIG customers to register and activate accounts on the new Space-Track website. Although the CSO had implemented on Space-Track more than half the OIG capabilities by early September 2004, AFSPC Commander General Lance W. Lord still waited for delegation of authority from the Secretary of Defense to conduct the pilot program. This delegation and assignment of responsibility finally occurred on November 8, 2004, but the CFE Space-Track website remained inoperative until January 3, 2005. Meanwhile, on December 30, 2004, NASA's OIG website posted a notice that it no longer would accept new users.[72]

Closure of the OIG website and provision of all its former capabilities, free of charge, to users via the Space-Track website would characterize the CFE pilot program's second phase of operations. Ultimately, the provision of more advanced services and products on a fee-for-service basis would constitute a final, third phase. On January 10, 2005, a notice posted on the OIG website said it would shut down on March 31, 2005. After the OIG website experienced severe technical difficulties—i.e., hardware and software failures—in early February, however, NASA decided as of February 14, 2005, to abandon all further attempts to recover the system. The new Space-Track website finally achieved the full functionality of the old OIG website in May 2005. By year's end, more than 16,000 users had established Space-Track accounts, and legislation the following year extended the CFE pilot program through September 30, 2009.[73]

Over the course of a half century, the focus of U.S. space surveillance activities and services had grown and shifted from merely tracking a single U.S. IGY satellite during its limited on-orbit lifetime to cataloging all man-made objects in space and to determining threats, human or natural, to operational satellites. At the end of July 2007, the space catalog listed 31,925 objects recorded since the launch of *Sputnik* in 1957, including 3,195 payloads and 9,064 pieces of debris still on orbit and being tracked by AFSPC.[74] To meet SSA requirements, NORAD and AFSPC decided in 2006 to move Cheyenne Mountain's Space Control Center to the Joint Space Operations Center at Vandenberg AFB, California, thereby consolidating it with other day-to-day space operations in support of warfighters around the globe.[75]

After a Chinese ASAT test on January 11,

2007, created thousands of additional debris fragments that stressed the capacity of the existing surveillance network, AFSPC undertook a comprehensive "clean sheet" review of its space-monitoring capabilities to plan beyond simply sustaining the Cold War architecture.[76] Working through the spring and summer, a "tiger team" laid the groundwork for the review by asking what, where, when, and why capabilities were needed for present and future space surveillance. By September 2007, the Space and Missile Systems Center at Los Angeles AFB, California, and the Electronic Systems Center at Hanscom AFB, Massachusetts, were using that team's data to complete a cost-and-performance analysis of candidate ground- and space-based surveillance systems to determine an overall "best value" for network performance. This meant, within funding constraints, that some existing systems might be scrapped, others improved, and new ones added to satisfy changing requirements.[77] It seemed another chapter in the development of space surveillance was about to begin. ■

NOTES

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Architecture Study" was begun in Jan. 1982 to address ways of correcting deficiencies in the existing network and how best to satisfy evolving requirements through the year 2000. See HQ USAF/CV, "Space Surveillance Architecture Study—Final Report," 2 Vols., Jun. 10, 1983; E-Mail, Col James Strub, USAF (Ret), to author, September 4, 2007 (hereafter cited as Strub, Sep. 4 2007).

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Hotel, Anaheim, California, pp.208-11; Amy Butler, "DOD Looks to Speed Up Haystack Effort," *Aviation Week*, Jul. 28, 2008.

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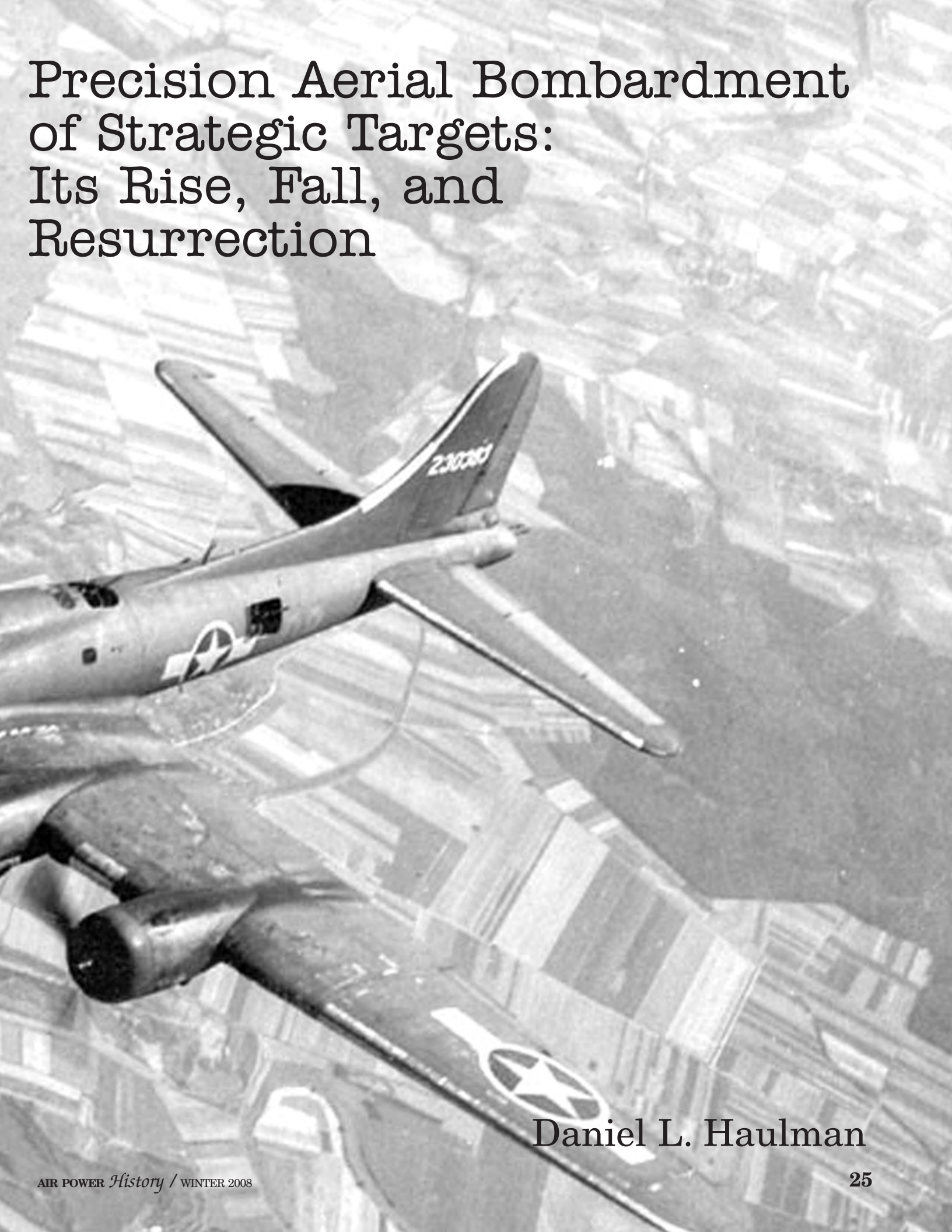
Precision Aerial Bombardment of Strategic Targets: Its Rise, Fall, and Resurrection



Daniel L. Haulman

(Overleaf) B–17 Flying Fortress over a European town. American heavy bombers over Europe during World War II included both B–17 Flying Fortresses and B–24 Liberators. *(All photos courtesy of the author.)*

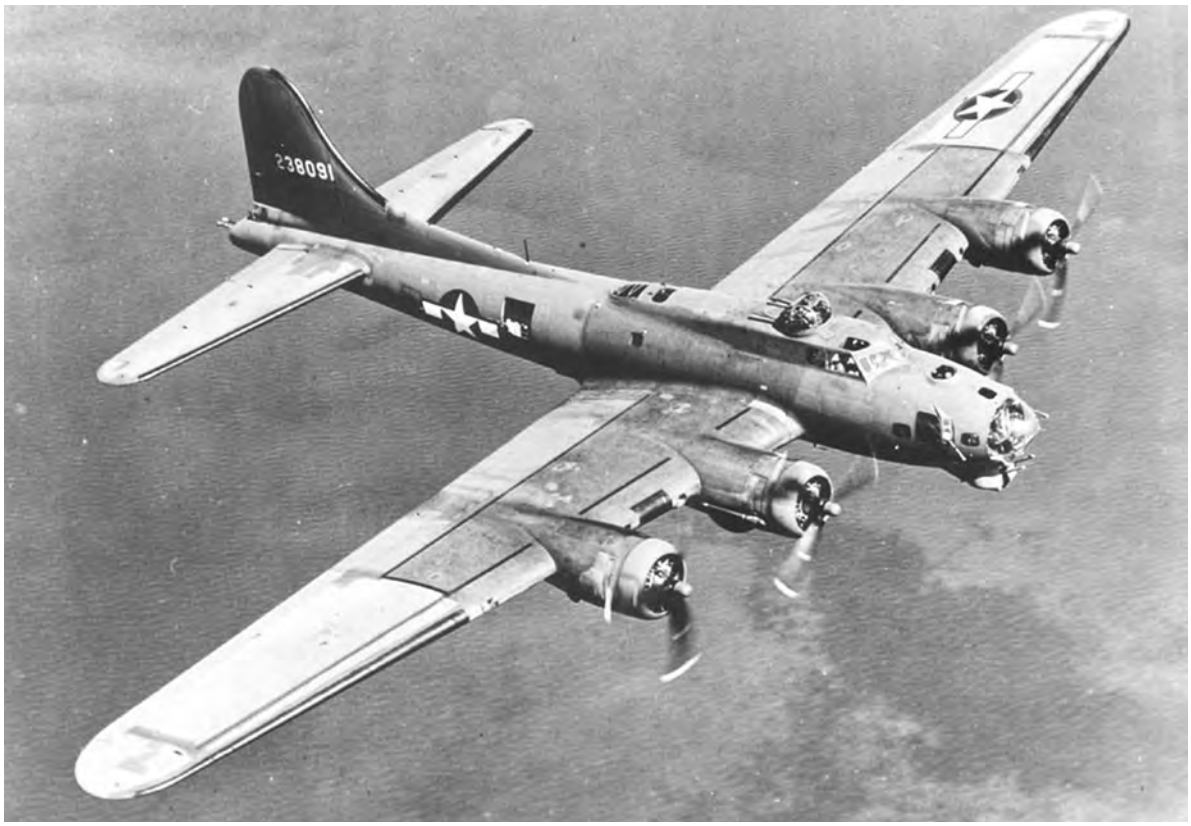
Air power theorists expect technology to follow them, and translate their ideas into reality. Sometimes, however, theory cannot be practiced, because it outruns technology. In that case, the theory must be modified to fit what is practicable. Sometimes technology leads theory, instead of the other way around. Such was the case of aerial bombardment in the twentieth century.

Strategic Bombing Theory

The United States Army Air Corps entered World War II confident that it could destroy key strategic enemy targets with precision daylight raids. Over the course of the war, however, the United States largely abandoned the attempt and resorted to wholesale bombing of enemy cities, often with incendiaries at night. This paper will explore the emergence of the concepts of precision and area bombing, explain why the latter idea prevailed during the war, and describe how the precision idea eventually triumphed.

During the 1930s, Army Air Corps officers, such as, Maj. Donald Wilson, Capts. Harold L. George and Laurence S. Kuter, and Lts. Kenneth N. Walker and Haywood Hansell, refined the precision bombing concept at the Air Corps Tactical School at Maxwell Field, Alabama. They conceived of the enemy war machine as a complex set of interconnected manufacturing, transportation, electrical, communication, and fuel distribution systems. Destroying key targets in these systems, they reasoned, would paralyze the machine, without having to target the enemy population. If the enemy lacked the capability to make war, whether he had the will to make war would make little difference. The Air Corps Tactical School ideas were incorporated in AWPD-1 (Air War Plans Division plan 1), which in

The B–17 Flying Fortress bomber was developed to realize the strategic bombing theory developed at the Air Corps Tactical School. It carried 10-12 machine guns and was originally designed to get to its targets without fighter escort.



THE UNITED STATES ARMY AIR CORPS ENTERED WORLD WAR II CONFIDENT THAT IT COULD DESTROY KEY STRATEGIC ENEMY TARGETS WITH PRECISION DAYLIGHT RAIDS

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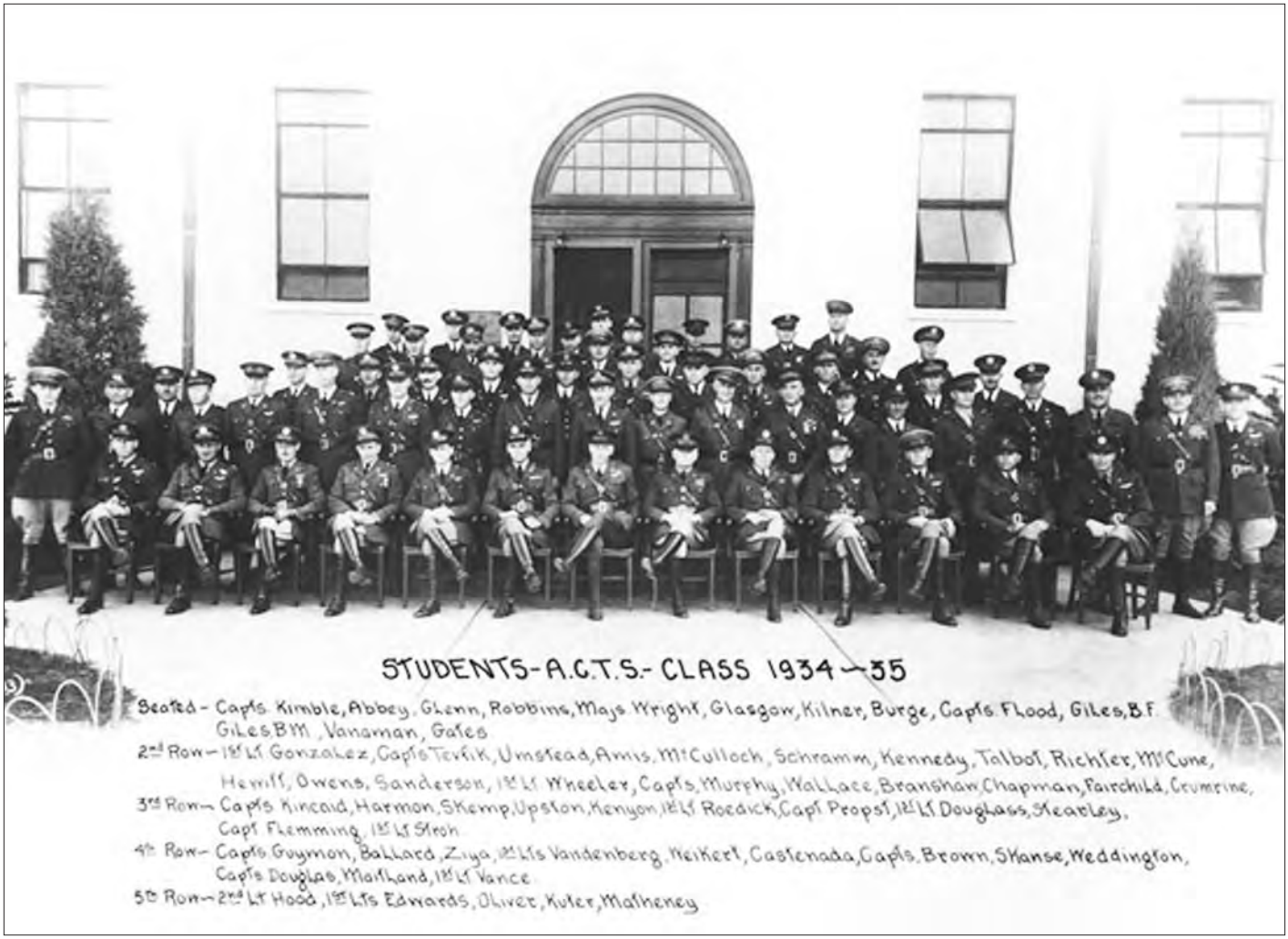


Air Corps Tactical School, Class of 1934-1935. Many of the class members went on to become Air Force general officers. The Air Corps Tactical School (A.C.T.S.) was the birthplace of the precision bombardment idea.

August 1941 became the blueprint for American bombing in the European theater during World War II.[1]

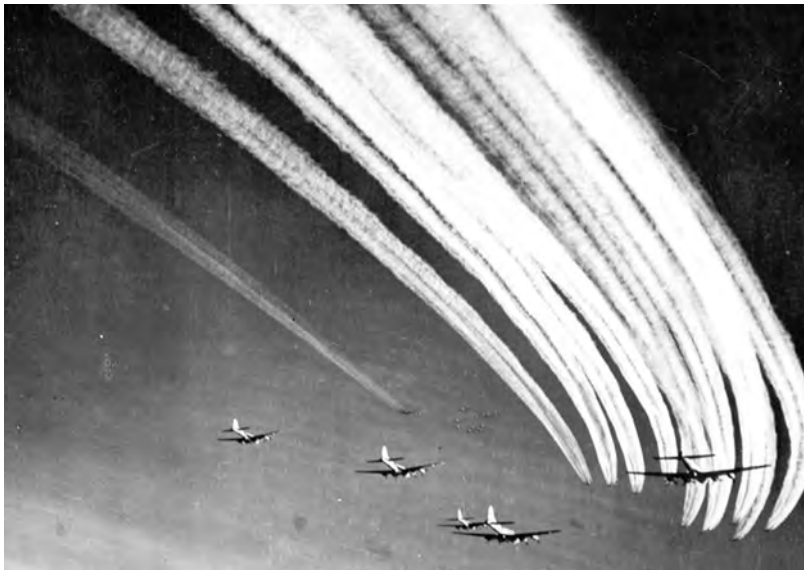
The revolutionary four-engine B–17 bomber, with its ability to fly faster and higher than contemporary fighters, and armed with ten to twelve high-caliber defensive machine guns, was intended to translate the theory into practice. Designers thought that such a bomber would always "get through" to the target by overcoming enemy antiaircraft fire and interceptors, even without fighter escorts, which originally lacked the bombers' range, altitude, and armament. Not long after the B–17 bomber entered the service, it was joined by another four-engined heavy bomber of comparable performance: the B–24 Liberator. With sophisticated instruments, including the Sperry and later Norden bombsights, the American bombers could theoretically hit targets, such as key factories or transportation hubs or oil refineries, with precision.[2]

THE BOMBERS HAD TO FLY EXTREMELY HIGH TO AVOID FLAK AND FIGHTERS

Before the United States entered World War II, the Germans and the British had already tested the alternative of area bombing. German aircraft terror-bombed Guernica in Spain in 1937 during the Spanish Civil War. The Luftwaffe also largely destroyed central Warsaw during the invasion of Poland in 1939, and central Rotterdam during the invasion of the Netherlands in 1940. In the summer of 1940, German airplanes began raiding London at night, using fire bombs.[3]

It was natural for the British to follow suit and bomb German cities, but there were other reasons for the Royal Air Force to resort to area bombing. Early in the war, Bomber Command tried daylight bombing of German targets, and quickly learned how costly that could be. Daylight raids on naval facilities at Wilhelmshafen on December 14 and 18, 1940 resulted in the loss of seventeen of thirty-six Wellington bombers. In contrast, contemporary night leaflet-dropping and reconnaissance missions encountered almost no enemy opposition, because neither German antiaircraft artillery nor German interceptors could see the Royal Air Force airplanes very well. Bombing at night, however, deprived the bombardiers of the ability to hit specific targets with precision. The bombers had to fly extremely high to avoid flak and fighters. On December 16, 1940, Bomber Command launched its first designated city raid on Mannheim. Subsequent photographic reconnaissance revealed poor results. D. M. Butt, assistant to Prime Minister Winston Churchill's personal scientific advisor, Lord Cherwell, reported that in June and July 1941, only one bomber in five dropped its bombs within five miles of the target. [4]

Despite the poor accuracy, the Royal Air Force



B–17 bombers in formation, leaving contrails. Huge formations of heavy bombers attacking marshalling yards near the centers of major cities would often leave those cities in ruins.

decided to concentrate on area bombing of cities at night rather than precision bombing of strategic targets during the day. Bomber Command reasoned that by destroying whole urban areas, they were bound to also demolish German factories, power plants, railroad yards, and fuel storage sites. In addition, they would "dehouse" German workers, crippling their ability to work. In short, the British would destroy the same strategic targets the Americans had in mind, but also everything around them, including large numbers of civilians. Such tactics might hasten victory also by destroying the enemy's will to fight.[5]

AS THE WAR WENT ON, THE AMERICANS DRIFTED AWAY FROM BOMBING SPECIFIC STRATEGIC TARGETS AND BEGAN TO PRACTICE AREA BOMBING OF CITIES

The British introduced electronic systems to improve the accuracy of their night bombing, including Gee, Oboe, and H2S. But none of these radio-based systems was sophisticated enough to allow precision bombing of strategic targets. They allowed the British to hit cities obscured by darkness and clouds, but not to hit specific targets within those cities.[6]

Area Bombing

After the United States entered the war, the American concept of precision bombardment and the British concept of area bombing came to coexist in the Combined Bomber Offensive. Although the dual system was in effect beginning in August 1942, it was not formally approved until January 1943, at the Anglo-American summit conference at Casablanca. The British continued to area-bomb German cities at night, while the Americans on daylight raids aimed for specific strategic targets. The around-the-clock bombing allowed a comparison of the two bombardment concepts. Although the Germans could not hit the British bombers as easily at night as they could the American bombers in daylight, the Americans suffered fewer lost bombers than the British, partly because of the hazards of night flying and weather. Still, the American bomb crew casualties were high. Approximately sixty American bombers were shot down or irreparably damaged on each of two disastrous raids on Schweinfurt, where they aimed for ball-bearing factories. Each B–17 or B–24 heavy bomber downed meant the loss of ten crewmen. Despite the later addition of long-range P–51 escort fighters, the Americans continued to experience high bomber loss rates, although not as high as the British.[7]

Mounting losses of bombers to enemy antiaircraft fire and fighter aircraft was not the only problem. Even with the highly-touted Norden bombsight, which some claimed would allow a bomber at high altitude to hit a "pickle barrel" on the ground; the American bombers were notoriously inaccurate. The idea was to hit a key target within an enemy city, but most of the bombs landed hundreds of feet away from the target. In order to ensure the target's destruction, and decrease the bombers' vulnerability, commanders sent large formations over the target with the hope that at least some of the bombs would hit the right spot. The result was that the daylight bombing was sometimes little different from area bombing. German cities were clustered around marshalling yards and factories, and destruction of those targets also usually involved destruction of the urban areas around them.[8]

The greatest obstacle to accurate American bombing was the weather. Clouds often obscured enemy targets, especially during the day. In the winter, the days themselves were extremely short. Bombers sometimes launched toward an enemy target but when they reached the area the crews could not see the ground. At first the crews lacked any kind of radar with which to "see" through the overcast. They would either have to abandon the mission, try to find a hole in the clouds, or drop bombs anyway, attempting to get close to the target.[9]

As the war went on, the Americans drifted away from bombing specific strategic targets and began to practice area bombing of cities. The Eighth Air Force flew its first mission to bomb a city as a target on September 27, 1943 with a raid on the port of Emden. This was also the first operational use of radar by American bombers. It was used to strike targets through the overcast. The American radar used for bombing, called the H2X system, was based on the British H2S system, which used radio waves to determine the contrast between rivers and land areas to determine the location of cities obscured by clouds. In a July 21, 1944, memo, Gen. Carl Spaatz's deputy for operations, Gen. Fred Anderson noted to operational commanders: "We will conduct bombing attacks through the overcast where it is impossible to get precision targets." Bombing through the clouds, even with the radar system, however, produced poor results.

Meanwhile, the British never abandoned daylight bombing completely, so the line between the British and American systems was not always clear cut. By the end of the war, more than half of Bomber Command's total effort was devoted to city-area bombing. From January 1942 to the end of the war, the Royal Air Force spent 56 percent of its heavy bomber sorties on city-area bombing. Experts estimate that the Eighth Air Force dropped some 13 percent of its bomb tonnage in

General Carl A. Spaatz, commander of the Eighth Air Force in World War II and later first Chief of Staff of the United States Air Force. He believed in the precision bombardment of key military targets rather than the wholesale bombing of cities.

city-area attacks. After September 26, 1943, the Eighth Air Force flew 23 percent of its sorties on city-area raids, including 253 incendiary bomb raids against German cities. The Fifteenth Air Force, on the other hand, flew only six raids against enemy cities as a whole. The most significant ones were two fire-bombing attacks on Vienna on November 5 and 6, 1944. Measured in tonnage, the percentage of incendiary bombs dropped is enlightening: for the Royal Air Force it was about 20 percent, but for the Army Air Forces it was about 10 percent.[10]

Together, the Army Air Forces and the Royal Air Force dropped between 600,000 and 675,000 tons of bombs in city-area raids in Europe. The number of German civilians killed in Allied bombing raids on cities varies widely, depending on the source. The British estimated the figure at some 300,000, while the postwar German Democratic Republic put the number at 410,000. Regardless which figure one accepts, the number of civilian casualties was very high.[11]

Bombing Japan

The United States tried precision daylight bombardment of strategic targets in the Pacific Theater of Operations, but that worked no better than it had against Germany. In a December 17, 1944, letter from Gen. Henry H. "Hap" Arnold, head of the Army Air Forces, to Maj. Gen. Curtis E. LeMay, who commanded AAF bombers based in India, Arnold noted, "I have just learned that on the Singapore attack 41 percent of your bombs were within 1,000 feet of the briefed aiming point. I don't have to tell you that I am impressed by this progress." Put another way, 59 percent of the bombs landed beyond 1,000 feet of the aiming point, and that was considered progress. Even the use of B–29s, the most advanced bombers of World War II, failed to solve the problem. Between November 29, 1944, and January 19, 1945, the XXI Bomber Command launched twelve major missions against Japan. Bombing results of at least ten of these raids failed to meet expectations. Evaluators of the effectiveness of the high-altitude precision bombing ranged from nil to poor.[12]

Attacking Japan from the heavy bomber bases in the Marianas did not help. The B–29s were equipped with pressurized and heated cabins, allowing them to fly at extremely high altitudes to reduce their vulnerability. But when they flew over Japan, they encountered the previously undiscovered jet stream winds, that either blew them off course, hindered their speed, or carried them too swiftly over their targets for accurate releases. Moreover, Japan was often covered with clouds, obscuring the targets. Even without such problems, the bombers were no more able to hit their targets in Japan than they were in Germany. The technology of the time did not allow the precision bombing of Japan.[13]

By March 1945, General LeMay, head of the XXI Bomber Command in the Marianas, had decided largely to abandon high-level daylight precision bombardment of Japan in favor of low-level fire-bombing of Japanese cities at night. He reasoned that such tactics would destroy key targets, even if much else around them was also destroyed. Flying low at night would allow the bombers to carry more bombs and less armament. The fire bombing of major Japanese cities beginning in March 1945 and continuing into the summer destroyed hundreds of square miles of urban area because Japanese architecture was more vulnerable to fire than was that of Germany. For example, on the night of March 10-11, 1945, 279 B–29s struck Tokyo with incendiary bombs, destroying a fourth of the city and killing more than 83,000 people. LeMay predicted that the destruction of Japanese cities by fire, coupled with an aerial mining campaign around the home islands, would eventually force Japan to surrender, even without an invasion.[14]

Not everyone agreed with LeMay. Army leaders firmly believed that Japan would not surrender without an invasion, and continued to prepare for it. On the other hand, members of the United States Strategic Bombing Survey were actively investigating the successes and failures of strategic bombing. Paul Nitze, a member of the survey, predicted that strategic bombardment of key transportation targets in Japan could bring about a

The B–24 Liberator bomber was produced in greater numbers than any other American aircraft in World War II. It served in both Europe and the Pacific.

THE ARMY AIR FORCES DEVELOPED A RADIO-GUIDED AZIMUTH-ONLY (AZON) GLIDE BOMB AND TESTED IT IN EUROPE AND THE CHINA-BURMA-INDIA THEATER

Japanese surrender by March 1946, without the continued fire-bombing of whole cities.[15]

Guided Bombs

During World War II, the Army Air Forces developed a radio-guided azimuth-only (AZON) glide bomb and tested it in Europe and the China-Burma-India Theater, where they promised some success against bridge targets. The Army Air Forces also experimented with other precision-guided weapons, but with less success. The new weapons were essentially "dumb bombs" equipped with radio-controlled flight control surfaces. Leaders of the ongoing bombing campaigns were reluctant to interrupt conventional bombing operations by introducing new weapons of questionable utility, given the limited technology of the day. The theory outran the practice, and practical, precision-guided bombs had to wait for later conflicts.[16]

Regardless of how effective strategic bombardment was, by the time the atomic bomb was available to use against Japan, the United States had already largely abandoned the idea of precision bombardment of key targets and resorted to the British system of fire-bombing urban areas at night. During the summer of 1945, only about a fifth of the total B–29 effort was devoted to daylight precision attacks. On the night of August 1-2, 1945, 627 B–29s fire-bombed four Japanese cities. It was a very small step from the incendiary bombing of Japanese cities to the atomic bombing of Hiroshima and Nagasaki. In either case, the centers of the cities were destroyed, along with thousands of civilians. The surrender of Japan days after the atomic bombings convinced many Army Air Forces leaders that the decision to destroy enemy cities was the correct course.[17]

Despite the drift of the United States away from the idea of strategic bombing of key military targets and toward the wholesale bombing of cities, a cadre of Army Air Forces leaders continued to favor precision bombardment over area bombing. Even during the first years of the Cold War, they planned potential missions to destroy the Soviet fuel industry that reflected the lessons of the Eighth and Fifteenth Air Forces in their attempt to destroy the German fuel system. One of the leading advocates of precision over area bombing throughout World War II was General Carl A. Spaatz, who became the first Chief of Staff of the U.S. Air Force when it was established in September 1947.[18]

The Korean War and Beyond

The Korean War, beginning in 1950, demonstrated that the United States lacked the same kind of dominance in conventional warfare that it possessed in nuclear warfare. President Dwight D.

The B–29 Superfortress, the most advanced bomber in World War II, was used not only for the night time incendiary bombing of Japanese cities but also for the atomic bombings of Hiroshima and Nagasaki. It was originally designed for precision bombing of strategic targets.

THE CITY BOMBING OF WORLD WAR II BECAME THE PARADIGM OF COLD WAR PLANNING FOR AIR OPERATIONS

Eisenhower's election in 1952 seemed to validate the concept of nuclear deterrence, or the idea of discouraging small conventional wars such as that in Korea by threatening to use nuclear weapons against what seemed to be the communist centers of aggression in the Soviet Union or China. Although the United States by 1953 no longer possessed a monopoly of nuclear weapons, it still held a preponderance of the weapons and the means for delivering them by air. As nuclear weapons became more and more lethal, the idea shifted from hitting key targets in the Soviet Union to destroying the cities as a whole. New hydrogen bombs with several times the destructive power of the atomic bombs that had destroyed Hiroshima and Nagasaki were not designed for precision targeting.[19]

SLOWLY, THAT CONCEPT ERODED. THE UNITED STATES FOUGHT IN KOREA AND VIETNAM WITHOUT BOMBING WHOLE CITIES

The city bombing of World War II became the paradigm of Cold War planning for air operations. The United States Air Force favored its Strategic Air Command, equipping it with long-range nuclear-armed bombers that could fly to the other side of the world and completely destroy enemy cities. The Union of Soviet Socialist Republics quickly adopted the same idea, and developed long-range bombers and nuclear weapons in order to ensure the destruction of American cities. The invention of intercontinental ballistic missiles armed with hydrogen bomb warheads bolstered the argument that the way to defeat the enemy was to destroy his cities.[20]

Slowly, that concept eroded. The United States fought in Korea and Vietnam without bombing whole cities. The Air Force concentrated on close air support of ground forces or air-to-air combat in order to achieve air superiority. It largely abandoned the idea of strategic bombardment in Korea or Vietnam, partly because those countries lacked much industrial infrastructure. Technology improved bombing accuracy, so that the average circular error probability decreased from 3,300 feet in World War II to 1,000 feet in Korea to 400 feet in Vietnam. In Korea, the U.S. Air Force employed the radio-controlled Tarzon bomb to attack bridges successfully. In the course of the Vietnam war, the requirement to destroy enemy bridges encouraged the development of precision-guided munitions such as laser-guided or television-guided bombs. Operation LINEBACKER I between May and October 1972 involved the first sustained use of precision-guided munitions in history. F–4C aircraft of the 8th Tactical Fighter Wing, using a combination of electro-optically guided and laser-guided glide bombs, destroyed more than 100 enemy bridges between April 6 and June 30, 1972, including the Paul Doumer and Thanh Hoa bridges that seemed impervious to countless previous bombing raids. Once precision-guided weapons became available, the precision bombardment concept regained favor.[21]

Operation LINEBACKER II in December 1972 represented the end of an era. It was the last time massed bomber formations dropped unguided iron bombs on enemy targets. In eleven days, the Air Force destroyed a host of key targets in the Hanoi and Haiphong areas of North Vietnam, but fifteen of the B–52 bombers went down and these losses doomed the future of massed bomber formations. The abandonment of such tactics contributed to the demand for more accurate munitions for fewer aircraft, and decreased the likelihood that cities would be targets in themselves.[22]

Revival of Precision Bombing

Other factors encouraged a revival of the precision bombing idea. Reconnaissance and surveillance satellites and U–2 and SR–71 reconnaissance aircraft vastly improved the collection of vital intelligence. Knowing where the key enemy targets were was just as important as being able to strike a point with precision. Stealth technology also contributed, by increasing the likelihood that bombers would reach their targets. In November 1988, the Air Force announced the F–117 stealth fighter (really a bomber), previously a classified weapon system. At the time, the United States possessed a monopoly on stealth technology. Constructed of composite materials with a special shape, the new aircraft was invisible to most radar. Combining missile and aircraft technology also contributed to the success of the precision bombardment idea, because missiles launched from aircraft were obtaining greater accuracy as air-to-ground weapons.[23]

DURING THE 1980S, AIR POWER THEORISTS SUCH AS COL. JOHN A. WARDEN III ENCOURAGED REVIVING THE PRECISION BOMBARDMENT CONCEPT

During the 1980s, air power theorists such as Col. John A. Warden III encouraged reviving the precision bombardment concept. Like the Air Corps Tactical School instructors of the 1930s, Warden believed that destruction of key targets would paralyze an enemy. He reasoned that air power should ignore the enemy's fielded armies and instead go after key facilities behind enemy lines. What distinguished John Warden's theory from that of some of his fellow Air Force officers was not really precision bombardment, because both Warden and others believed the technology allowed the destruction of almost any target with precision. Warden, however, preferred command and control targets in the enemy capital, such as power plants or communication facilities, rather than tactical targets on the battlefield, such as bridges and tanks. In other words, target an enemy's head and heart, not his fists. A combination of precision-guided munitions, much more effective satellite intelligence, and stealth technology, made Warden's theory practical.[24]

Warden's ideas contributed to the air campaign against Iraq in early 1991 for the liberation of Kuwait. Lt. Gen. Charles A. Horner, air component commander for Operation DESERT STORM, depended in part on Warden's ideas in order to destroy key command-and-control targets within Iraq, especially in the capital, Baghdad, and thus facilitate the quick victory that resulted. Although the victory was not achieved without a ground offensive, that short-lived campaign succeeded largely because of the weeks-long air campaign that preceded it. DESERT STORM vindicated fully the idea that airplanes can be most effective as strategic instruments because they can strike key targets with precision. A combination of theory and technology contributed to the success of the air campaign. In 1990, only the U.S. Air Force possessed an air-delivered precision-guided munition, the BLU-109, capable of penetrating six feet of hardened concrete. The circular error probability for bombs dropped during the first Gulf War was only ten feet. F–117 pilots dropping laser-guided bombs hit their targets with nearly 80 percent of the 2,065 weapons they released. Most of the stealth aircraft attacks targeted the heavily-defended Baghdad area.[25]

Although bombing of strategic targets, often employing stealth aircraft and precision-guided munitions, represented only about a quarter of the total air effort against Iraq in 1991, it contributed perhaps more than any other factor toward the victory in Operation DESERT STORM. In the first ten days, January 17-26, 1991, attacks on strategic targets exceeded air attacks on other targets. By January 27, the Air Force was able to devote more attention to attacks on tactical targets and fielded enemy forces, because enemy systems had already been disabled.[26]

The idea of precision bombardment developed further during Air Force operations in the former Yugoslavia in the 1990s. During Operation DELIBERATE FORCE in 1995, for the first time in the history of air campaigns, the number of precision-guided munitions exceeded the number of "dumb bombs", and targets were destroyed with greater precision than ever before. In 1999, during Operation ALLIED FORCE over Serbia, the Air Force first employed the Joint Direct Attack Munition (JDAM), which applied radio-controlled flight surfaces to dumb bombs to make them "smart." Accurate guidance came from Global Positioning System (GPS) satellites. Although not more accurate than the laser-guided bombs, the JDAMs could be used when the air was not clear, and they were less costly. USAF airplanes dropped 652 JDAMs during the 1999 operation, and more than 80 percent hit their targets.[27]

By the close of the twentieth century, key Air Force generals, including Lt. Gen. Charles A. Horner and Gen. George L. Butler, had come to the conclusion that nuclear weapons were no longer necessary in the arsenal of the nation, and should be eliminated entirely. If the nation's air force no longer needed to destroy enemy cities in order to win a war, because of the success of precision bombardment of key targets, weapons of mass destruction were militarily useless. Moreover, the United States could more easily discourage the proliferation of nuclear weapons in the world if it gave up those weapons as well. The only rationale for keeping such weapons is to deter an enemy from using them.[28]

Americans in World War II reluctantly abandoned precision bombing and began to destroy whole cities from the air. Fifty years of evolving technology resurrected the precision bombardment idea that had been born in the Air Corps Tactical School of the 1930s. In Operation ALLIED FORCE in 1999, the North Atlantic Treaty Organization, using air power alone, defeated Serbia in a short war. There were no NATO casualties in battle and few enemy casualties as well.[29] Proper application of air power turned precision theory into practice, proving that wars could be won without mass casualties after all. ■

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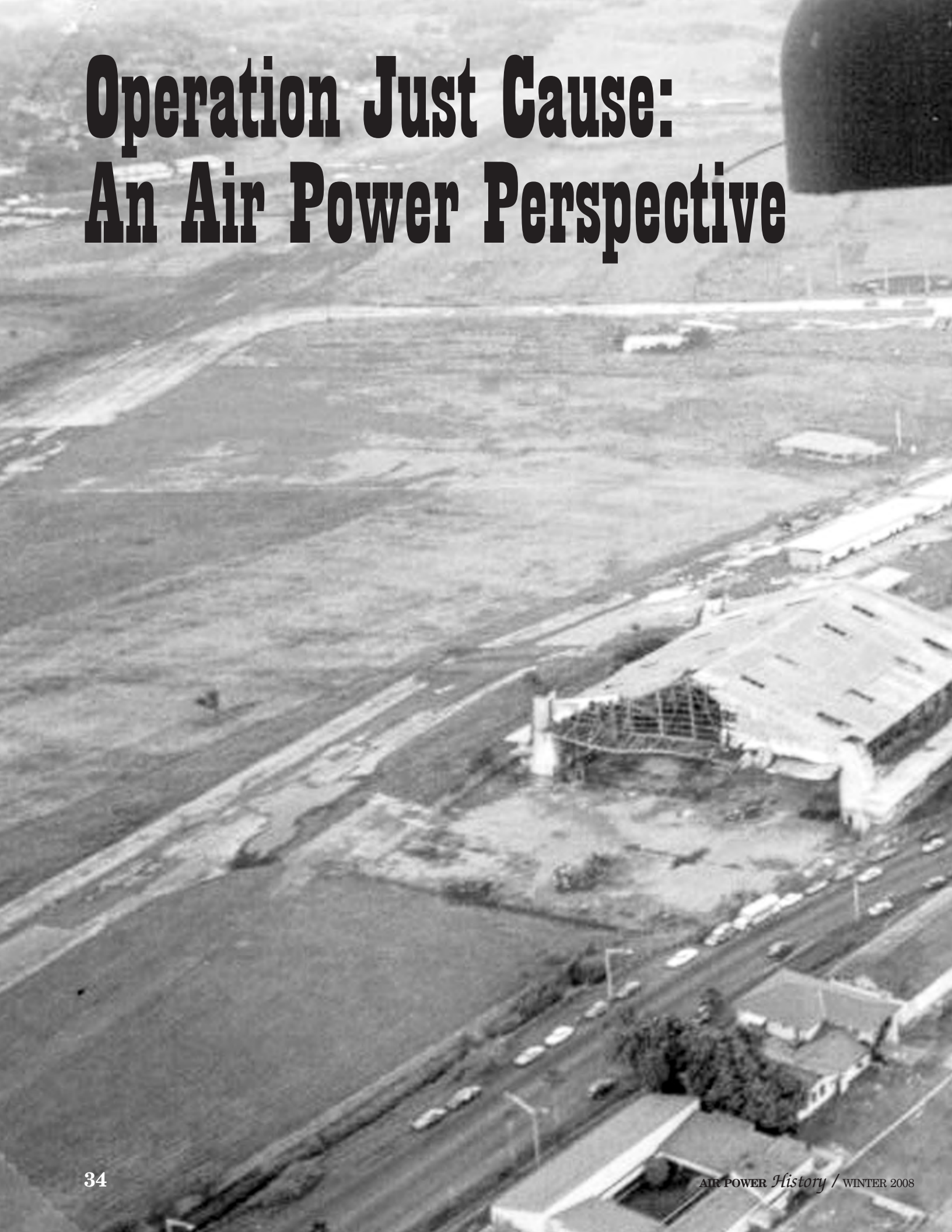
Operation Just Cause: An Air Power Perspective



Stetson M. Siler

(Overleaf) Damaged Panamanian Defense Force facilities on the edge of Albrook AFS. The remnants of the very old Albrook runway are visible to the left. This facility dates back to early passenger traffic by Pan American Airways in the 1930s. *(Unless otherwise credited, all photos courtesy of the author.)*

Operation JUST CAUSE, the invasion of Panama in 1989, was launched to apprehend and bring to justice Manuel Noriega, and return a democratic government to Panama. This was the first significant large-scale post-Vietnam operation for the United States military, and the first combat test of the Goldwater-Nichols Act, enacted in 1986 to fix shortfalls with inter-service cooperation and integration. Although a successful operation, Operation JUST CAUSE was plagued by problems with organization, planning, and execution. This article will describe the operation, highlight problems and draw conclusions about the success of inter-service cooperation.

[JUST CAUSE] WAS THE FIRST SIGNIFICANT LARGE-SCALE POST-VIETNAM OPERATION FOR THE UNITED STATES MILITARY, AND THE FIRST COMBAT TEST OF THE GOLDWATER-NICHOLS ACT

Panama: The Strategic Landscape, 1989

United States forces were stationed in Panama during the building of the canal, and remained until retreat sounded on the United States military installations on the last day of 1999. United States forces were in Panama during most of the Twentieth Century to guarantee the access of naval and commercial traffic to the canal. The canal's strategic importance during World War II required a large force to guard the canal and its approaches, as German submarines operated in the Caribbean Sea.[1] In 1989, there were 10,000 United States military personnel in Panama, ostensibly to defend the canal, but also to fight the drug war, and to reach out to Latin American military forces.

The Carter-Torrijos Treaty went into effect in 1979 and specified a twenty-year period for transition of ownership of the canal from the United States to Panama, with the final turnover December 31, 1999. By 1989 the transition was well along, with the symbolic half-way point scheduled to be the change to a Panamanian Canal administrator on January 1, 1990.[2] The treaty specified a gradual change in the nationalistic composition of the canal workforce and disestablished the Canal Zone, the ten mile strip with the canal at its center, as sovereign United States territory.

The United States Southern Command (SOUTHCOM) is the Unified Command responsible for all military operations in Latin America. In 1989, SOUTHCOM, headquartered at Quarry Heights, Panama, faced a situation different from other Unified Commands in terms of the military threat and the nature of the assigned missions. In addition to continuing responsibility for the defense of the canal, the command was dealing with drug cultivation and trafficking in its Area of Responsibility. Other key missions were military-to-military contacts to enhance the professional stature of the Latin American military forces, and a range of nation building operations to enhance United States prestige in the region. SOUTHCOM was also more limited in scope in terms of assigned forces compared to the other Unified Commands; the largest service component was the United States Army South, and their main combat force, the 193d Infantry Brigade, stationed in theater in Panama. The senior United States Air Force unit in the theater, the 830th Air Division, had operational control of limited fighting forces: guard, reserve, and special operations forces maintained rotational units of fighters, transports, and gunships at Howard AFB, and the organic 24th Composite Wing had a squadron of OA–37s permanently assigned. The Navy also had a small contingent in theater.[3]

Another factor present in 1989 was the recently enacted Goldwater-Nichols Act. This 1986 Act assigned greater emphasis to the theater CINCs and to joint war fighting.[4] The Act strengthened the role of the Chairman of the JCS, better specified the role of the regional Commanders-in-Chief, and outlined the training and promotion of Joint Specialty Officers (JSOs). The services were building up cadres of field grade JSOs, and were responsible for ensuring officers were adequately trained in joint warfighting and subsequently assigned to positions on joint staffs. JUST CAUSE would be the first opportunity for the significant employment of forces in combat since the enactment of the law.

Also in 1989, extensive planning was in progress for operations against Panamanian dictator and Panamanian Defense Force (PDF) Commander General Manuel Noriega. But as 1989 wore on, most service members viewed the trouble with Noriega more in terms of the Personnel Movement Limitations that were imposed on United States troops and the incidents of harassment of United States forces and civilians by the PDF, rather than the possibility of the invasion that took place in December.

Noriega had a long history with the United States. He was involved in dubious and illegal activities, including drug smuggling, money laundering, and selling United States military secrets to Cuba.[5] By 1989, Noriega had been indicted by United States courts for a series of drug related

Colonel Stetson M. Siler retired from the United States Air Force in the summer of 2006 after a thirty-year multifaceted career in test, evaluation, electronic warfare, intelligence, planning and programming, and education and training. He was on the SOUTHCOM J-5 staff at Quarry Heights, Panama, from July 1989 until August 1990, which included service during Operation Just Cause. Colonel Siler was also stationed at Headquarters, United States Air Forces, Europe during the time of the completion of the Intermediate Nuclear Forces Treaty, was on the B–2 Stealth bomber operational test team at Edwards AFB, California, and commanded an Air Force Reserve Officer Training Corps unit. His last assignment prior to retirement was as Chief of the Test and Evaluation Division on the A-3 staff at Headquarters, Air Force Materiel Command, Wright-Patterson AFB, Ohio. His decorations include the Legion of Merit and the Meritorious Service Medal with seven Oak Leaf Clusters.

Troops parade during the assumption of command ceremony by Gen. Maxwell Thurman on Sep. 30, 1989. The rainbow of uniforms led Gen. Thurman to order all his forces into BDUs.

crimes. A Panamanian national election was held on May 7, 1989. The election was observed by high ranking and credible observers, including former President Jimmy Carter, and several United States Congressmen. Despite Noriega's widespread election fraud, the opposition party of Guillermo Endara overwhelmingly won the election. Noriega annulled the election and installed his man into office, who the United States refused to recognize. At a rally by the ousted party in Panama City a few days later, Noriega's thugs confronted and publicly beat the winning candidates.

In the wake of the election turmoil, President George H. W. Bush ordered 2,000 additional troops into Panama. The President also ordered movement of all military families living on the economy onto United States installations.

General Thurman Arrives in Panama

On September 30, Gen. Maxwell "Mad Max" Thurman assumed command of SOUTHCOM. He had been convinced to postpone his planned retirement and take the SOUTHCOM command. In fact, President Bush was becoming increasingly impatient with Noriega and wanted a strong personality to replace Gen. Frederick Woerner. Stories going around the SOUTHCOM staff were that General Thurman worked twenty-one hours a day, and spent the other three sleeping on a cot in his office. Under General Woerner, Air Force members of the staff wore blues, and the Navy officers wore whites; this day-to-day routine was very apparent in the "pass in review" of the Command's troops during the change of command ceremony. General Thurman's first change came quickly as he ordered everyone into Battle Dress Uniforms (BDUs) as the duty uniform. As these weren't part of their uniform compliment, Navy officers scrambled to get BDUs issued by the Army.[6]

IN THE WAKE OF THE ELECTION TURMOIL, PRESIDENT GEORGE H. W. BUSH ORDERED 2,000 ADDITIONAL TROOPS INTO PANAMA

Three days after General Thurman assumed command of SOUTHCOM, a small group of PDF officers attempted a coup against Noriega. There was no United States participation in the ill planned and ill executed coup, which failed and cost the life of its leader and a number of his followers.

JUST CAUSE Planning

In the meantime, invasion planning was in high gear. For the operation against Noriega's regime, the United States Armed Forces were organized as a joint task force, designated as Joint Task Force-South, with Lt. Gen. Carl Stiner, the XVIII Airborne Corps Commander, in charge of the nominal joint force. The plan specified creation of several subordinate task forces (TF), including:

TF Atlantic, built around two brigades of the 7th Infantry Division, responsible for neutralizing PDF units in the Colon area;

TF Pacific, consisting of a brigade of the 82d Airborne Division, charged with an airborne insertion into the collocated Tocumen Airfield and Torrijos International Airport after the facility had been seized by the elements of the 75th Ranger Regiment, and then to conduct follow on attacks on Panama Viejo, the PDF infantry at Tinajitas, and Ft. Cimarron;

TF Bayonet, consisting of the Panama-based 193d Infantry Brigade, augmented by mechanized units from the 5th Infantry Division, assigned to capture the PDF Headquarters (*Comandancia*) and Ft. Amador;

TF Semper Fidelis, responsible for securing the Bridge of the Americas, spanning the Pacific end of the Canal, and protecting Howard AFB; and

Special Operations Forces TFs Red and White, assigned missions to seize Rio Hato Airfield, the initial assault into Tocumen Airfield and Torrijos International Airport, and operations against Patill Airfield and Ft Amador.

The airborne operations planned at Rio Hato and Tocumen/Torrijos were to be the largest night combat airdrop since World War II.

Planning by the staff of the XVIII Airborne Corps yielded a plan by an Army staff, centering on Army solutions. Coordination meetings with other participating organizations took place, but there was no organic representation from the other services on the staff. Most Air Force coordination took place with the Military Airlift Command (MAC), which supplied the lion's share of the Air Force forces to the operation. The XVIII Airborne Corps had discussions with the Air Force on air support for the Rio Hato airborne assault, but only in terms of how air forces could support the Army's plan, not alternative solutions to keeping Noriega's troops from reaching Panama City. Most of the rest of the air missions supporting the Army plan fell to the Air Force Special Operations Forces, particularly AC–130 gunships. There were also contentious discussions with the Navy over the issue of the assignment of a carrier battle group to provide tactical air power to the operation. Eventually, the carrier battle group was scrapped from the plan as there could

An air-to-air front view of an AC–130 Hercules aircraft in-flight . *(USAF photo.)*

AS COMMANDER OF THE TWELFTH AIR FORCE, LT. GEN. PETER T. KEMPF WAS THE AIR COMPONENT COMMANDER, BUT MOST OF THE AIR FORCES FELL ELSEWHERE ON THE ORGANIZATIONAL CHART

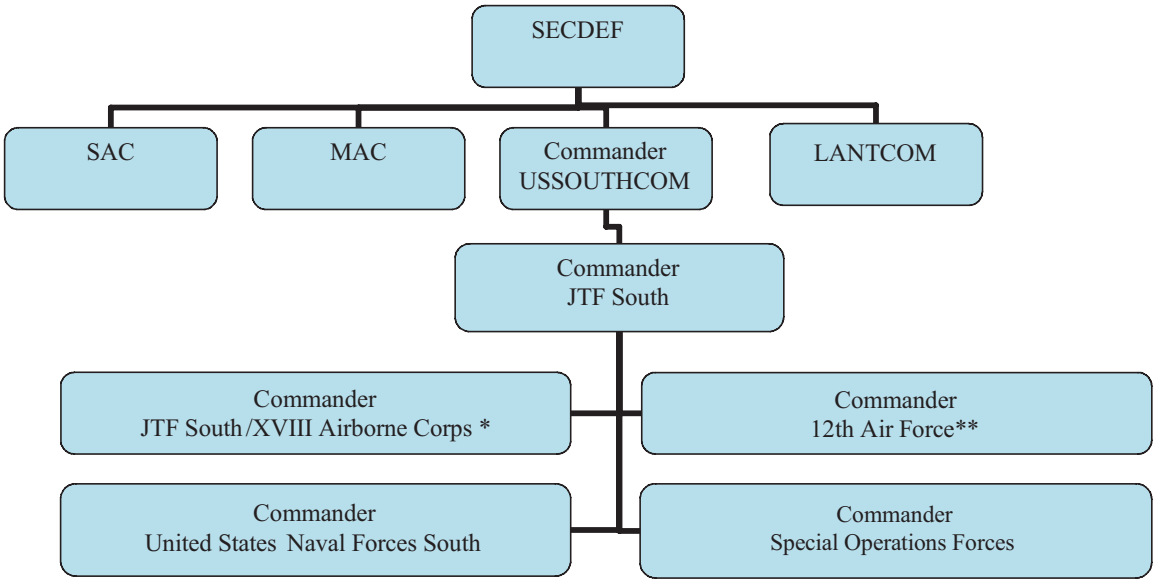
be no agreement concerning command and control. Another key issue that involved the Special Operations Forces was the building of the plan in the Joint Deployment System (JDS). Objections from both Special Operations Command and JTF South about security and the ability of the system to cope with the degree of detail required led to a decision by JCS Chairman General Colin Powell to exclude the Operations Order from the JDS. This significantly complicated planning of the deployment phase for MAC.[7] The eventual command relationships for Operation JUST CAUSE are shown in the chart on the facing page.

From the air power point of view, the command relationships were clumsy. As Commander of the Twelfth Air Force, Lt. Gen. Peter T. Kempf was the air component commander, but most of the air forces fell elsewhere on the organizational chart. The strategic mobility forces, which comprised the largest portion of the air component commitment, were under MAC and SAC. Special operations air forces, responsible for most close air support, were under the theater's Special Operations Component Commander.[8] The only forces directly under the SOUTHCOM air component commander were the rotational Air National Guard and Reserve A–7s and C–130s, and the in-theater OA–37s assigned to the 24th Composite Wing at Howard.

Movement of this massive force, necessary to bring overwhelming firepower to bear in a short period of time, would need major elements of Military Airlift Command to provide troop transports as well as movement of equipment and supplies, and the Strategic Air Command to provide air refueling. MAC planned for sixty-three C–141Bs, twenty-one C–130s, and two C–5s to perform the airland and airdrop missions. The plan called for troopers of the 82d Airborne Division to be loaded at Pope AFB, North Carolina, and flown directly to Panama for an airborne assault on Torrijos International Airport and Tocumen Air Base. Heavy equipment for the operation was also to be loaded at Pope, and then flown to the Charleston AFB staging area for air transport to Panama. Elements of the 75th Ranger Regiment were to be loaded at Hunter and Lawson Army Airfields and transported for the airborne assaults on Rio Hato and Torrijos/Tocumen airfields, the later drop to seize the field before the assault by the 82d. An additional twenty-six special operations aircraft, from MAC's Twenty-third Air Force, were also assigned to the operation, under the operational control of the Special Operations Component Commander.[9]

JUST CAUSE was unusual in that there were more than 12,000 U.S. troops stationed on "enemy" territory before and as the operation started. These troops were familiar with the rural and urban terrain. That this situation could exist testifies to the fact that most of the Panamanian population was pro-United States.[10]

The enemy forces to be countered in the war plan consisted of the PDF and irregular forces. The PDF consisted of all the branches of the armed forces, with a total strength of 12,800 personnel, about 4,000 of which could be considered combat troops. Ground forces consisted of two infantry battalions, five light infantry companies, one cavalry troop, and two public order companies. The Panamanian Air Force was a small organization, with 500 officers and enlisted personnel, twenty-one Bell 205A-1 helicopters, and a few light transports mainly tasked with flying supply missions for jungle bases.[11] The only significant air defense



* No separate Land Forces Commander designated
** Air Component Commander

weapon in the PDF arsenal was the ZPU-4.[12] With essentially no offensive Panamanian air power, and only a few air defense antiaircraft artillery pieces, the United States forces could count on air superiority by default. In addition to the several PDF company-sized units, there was also a substantial paramilitary force that Noriega had at his disposal in the so-called dignity battalions.

The air threat that JUST CAUSE planners did have to worry about was potential Cuban fighter interceptor interference with the invasion force headed for Panama. There was also a concern that if the Cubans detected the force on radar, they would at least provide an early warning to Noriega's forces. Considerable effort had gone into the route planning and the necessary support needed to proceed undetected to Panama. F–15s from the 33d Tactical Fighter Wing at Eglin AFB, Florida, were to provide a fighter combat air patrol near Cuba to guard against interference with the airlift. The routing for the air-bridge called for descending and transiting the gap between the Western tip of the island of Cuba and the Yucatan Peninsula, operating under radio silence, to remain undetected by the Cubans.

THE AIR THREAT THAT JUST CAUSE PLANNERS DID HAVE TO WORRY ABOUT WAS POTENTIAL CUBAN FIGHTER INTERCEPTOR INTERFERENCE WITH THE INVASION FORCE HEADED FOR PANAMA

By late November, Air Force airspace planners were introduced to the scope of the planning and became aware of the sheer number of aircraft participating in the operation. Up to this point, there had been very little coordination by the XVIII Airborne Corps with the Air Force on an air control and deconfliction plan. An airspace utilization conference was quickly setup at the headquarters of the air component commander at Bergstrom AFB, Texas, to hash out issues associated with the management of the airspace.[13] The state of the advanced planning that had occurred before this meeting demonstrates the problems associated with XVIII Airborne Corps operating as a quasi-joint headquarters.

In addition to the planning for the combat operations for Operation JUST CAUSE, a parallel effort was launched to plan restoration of civil authority in Panama. Unlike the rest of the planning, this responsibility was assigned to the SOUTHCOM's Directorate of Strategy, Programs, and Policy (J-5). Events would show that the level of planning for this phase of the operation would lag the effort put into the plan for the combat operations. Civil affairs, nation building, and assistance to foreign governments have traditionally been viewed as far less important missions by military forces, and naturally the emphasis for the planning centered on combat operations. The scope of the required Civil Affairs actions turned out to be far greater than expected, as the original plan envisioned that governmental structures would remain in place and would quickly resume functioning. An open question was what the replacement for the PDF would look like: would it have an exclusively civil police or a military role, and who would have responsibility for constituting and training this force.[14]

JUST CAUSE was triggered by the PDF's shooting and killing an off-duty U.S. Marine, Lt. Robert Paz, after a group of four officers in their privately owned vehicle became lost near the *Comandancia* on Saturday evening, December 16. President Bush ordered the execution of JUST CAUSE the next day, with H-Hour scheduled for 0100 on December 20, 1989. His objectives for Operation JUST CAUSE were to protect American lives, maintain the security of the Panama Canal, restore democracy to Panama, and to capture Noriega and bring him to justice.

Deployment Phase

The eighty-six transports that MAC assigned to perform the airlift missions were in motion from

home bases to staging locations shortly after the execute order. Despite the size of the operation and limited preparation time, the operation was taking place a few days before Christmas: more aircraft than usual were at home stations, and units were standing down or reducing operations. Peacetime airlift missions that were still operating were suspended to support the combat operations.

RIO HATO, ON THE PACIFIC COAST SOME 100 MILES WEST OF THE CAPITAL, WAS HOME TO ABOUT 500 TROOPS FROM THE PANAMANIAN 6TH AND 7TH INFANTRY COMPANIES, AND THE PANAMANIAN NCO ACADEMY

Pope AFB, North Carolina, adjacent to Ft. Bragg, was a beehive of activity. Troops and combat equipment of the 82d Airborne Division were streaming to the airfield. C–141B Starlifters with equipment loads were to proceed to Charleston AFB for staging, while the troop transports were to depart Pope directly for targets in Panama. The XVIII Airborne Corps did not recall their troops for the operation until December 19, so the planned time phased, orderly load up at Pope was squeezed into a tighter timeline. At one point, forty-five of the big airlifters crowded every square foot of Pope's ramps and taxiways, twelve more than the advertised "max on ground" factor used for planning, and nearly 20 percent of the entire USAF inventory of C–141s.

This crowding also challenged the aerial port troops responsible for loading the transports. And to demonstrate the "tides of fortune and fate" in combat operations, an ice storm was descending on the base, threatening to destroy the timing of the invasion and wreck the massing and surprise in the plan. A crew from the 62d Military Airlift Wing, McChord AFB, Washington, upon reporting to their aircraft, noted "foot long icicles" hanging from the wings.[15] There wasn't sufficient aircraft deicing equipment at Pope to prepare the transports for launch. Airlift units from as far away as Dyess AFB, Texas, flew in deicing equipment and fluids. The aerial port personnel and the waiting combat troops (ready to jump into the tropics) endured the miserable weather conditions, but the port personnel were greatly aided by local retirees and reservists who sensed that "something big" was afoot at Pope, and volunteered to help. The C–141s carrying equipment were typically overgrossed by 10 to 18,000 pounds, but were cleared to operate at wartime gross weights on a tail-by-tail basis by the Twenty-first Air Force Deputy Chief of Staff, Operations, Col. James Galyen, who was present on the Pope ramp. This overloading was aggravated by the short 7,500-foot runway at Pope. All the equipment-loaded C–141s were due out of Pope by 1800 on Monday, December 18, but due to confusion with load deliveries by the Army, and the delays to deice the aircraft, the last Starlifter didn't arrive at the planned staging area at Charleston AFB until 0830 on December 19.[16]

SAC aerial refueling aircraft were also marshalling to support the air bridge and escorting forces. KC–135 and KC–10 tankers were deployed to Seymour-Johnson AFB, North Carolina, and Barksdale AFB, Louisiana to support the operation.[17]

Meanwhile, at Lawson Army Airfield, near Ft. Benning, Georgia, C–130s from the 317th Tactical Airlift Wing from Pope AFB and MC–130s from the 1st Special Operations Wing at Hurlburt Field, Florida were loading Rangers of the 75th Regiment and their equipment to assault the PDF units and the airfield at Rio Hato. Other elements of the 75th Rangers were soon airborne from Hunter AAF near Ft. Stewart, Georgia, and headed for Tocumen Military Airfield outside Panama City. Their mission was to seize the airfield in advance of the drop of a brigade of the 82d Airborne Division.

The C–141s with the 82d Airborne Division troops did not fly in the planned single massed formation due to delays at Pope. They departed in four waves between 2130 and just after 2400. The C–141s, operating under radio silence, dropped down to 5,000 feet, and the C–130s operated at 3,000 feet to remain undetected by Cuban radar. Subsequent C–141s, trying to catch up with the main formations, didn't descend in the Cuba-Yucatan gap: the cat was out of the bag, and Noriega was already tipped off.

Present at Rio Hato, Torrijos/Tocumen, the *Comandancia*, and other locations where close air support might be needed were several AC–130 Gunships. These aircraft had either deployed in advance of the air armada or were already present in theater as part of the rotational force reacting to the building crisis. The Gunships were AC–130As of the 711th Special Operations Squadron (SOS) of the Air Force Reserve at Duke Field, Florida, and AC–130H Spectres of the 16th SOS at Hurlburt Field. The Gunship represented the greatest source of close air support, due to the limited fixed wing tactical air in the plan. General Stiner had said during the planning phase, "I didn't feel we needed air support if we went in at night and we maintained the element of surprise as much as possible."[18] The demand for Specters in the next 24 hours is evidence that this may have been short sighted.

Employment Phase: The Attack on Rio Hato

Rio Hato, on the Pacific coast some 100 miles west of the capital, was home to about 500 troops from the Panamanian 6th and 7th Infantry companies, and the Panamanian NCO Academy. As these units had proved loyal to Noriega during the October coup, and had proceeded to Panama City by air to thwart the coup attempt, Army planners decided that the field needed to be seized and the PDF units attacked directly. The attack was initiated around 0100 by two F–117s, which dropped two GBU-27 laser guided bombs in front of the barracks. These aircraft were employed directly from their home base at Tonopah, Nevada, and their attack was the first use of these aircraft in combat.

The details of this operation have been the subject of much controversy, dating to planning conferences where the need for these aircraft had been argued. The bombs didn't hit the PDF barracks, but fell into an open field. Initial reactions questioned why the vaunted F–117s, developed under great secrecy and presumably great expense, could miss their targets, especially in such a permissive environment? It was even characterized in some quarters as a stunt. However, the target had been changed late in the planning from the barracks

A U.S. Air Force F–117A 'Nighthawk' Stealth Fighter aircraft. *(USAF photo.)*

themselves to the nearby field. The targeting change was to create confusion immediately prior to the insertion of troops. Additional justification for the change was that the operation was "for the Panamanian people," and that destroyed barracks would have to be rebuilt.[19] Gen. Larry Welch, USAF Chief of Staff, said after the operation that he didn't want to use the F–117, but night targeting systems under development for F–15Es and F–16s weren't ready. General Welch thought the barracks weren't particularly important targets, and when the planners changed the targets from the barracks to the adjacent open field, he thought the revised targets even less so. The F–117s were cemented in the plan when the Ranger commander said that they could save lives. One F–117 hit its aim point in the field within five meters, but the second bomb missed its target by about 300 meters. This was later attributed to pilot error and not a deficiency with the aircraft's targeting system.

ONE F–117 HIT ITS AIM POINT IN THE FIELD WITHIN FIVE METERS, BUT THE SECOND BOMB MISSED ITS TARGET BY ABOUT 300 METERS. THIS WAS LATER ATTRIBUTED TO PILOT ERROR AND NOT A DEFICIENCY WITH THE AIRCRAFT'S TARGETING SYSTEM

However, instead of creating confusion, the bombs alerted the Panamanians, so that when the 15 C–130s loaded with troopers from the 75th Rangers arrived over Rio Hato they were confronted by the fire from several ZPU-4 14.5 mm guns. Gunships then started suppressing the air defenses. Thirty-five heavily-loaded troopers were injured landing on the concrete runway, but the Rangers swiftly recovered and attacked the main terminal of Rio Hato, which was secured by 0153. Shortly after three MC–130s arrived, bringing equipment and additional Rangers, and establishing a Forward Area Refueling and Rearming Point to support helicopter operations.

During the Rio Hato attack the Rangers lost two killed and twenty-seven injured (in addition to thirty-five troops injured during the landing), while the PDF lost thirty-four killed and 260 captured.[20] The PDF units were neutralized, and were eliminated as a threat for movement towards Panama City to aid Noriega.

Tocumen Military Airfield and Omar Torrijos International Airport

The initial phase of the assault on the adjacent civil and military facilities just outside Panama City was made by elements of the 75th Ranger Regiment. Objectives consisted of the Panamanian Air Force headquarters and recreation center, the 2d PDF Company, and the commercial air terminal. At H-Hour, 731 Rangers jumped from seven C–141s and four C–130s onto Tocumén. The airfield was quickly secured. At 0155, eight M-551 Sheridan light tanks[21] and other heavy equipment were dropped. At 0211 the next wave of twenty-eight C–141 transports dropped the paratroopers of the 1st Brigade of the 82d Airborne Division over Torrijos. Large numbers of transports were operating in close proximity at low altitude in blackout conditions without night vision equipment and unreliable station keeping equipment. Crews used the ILS to line up on the runway for the drop, and the absence of a midair collision is a tribute to the skill of the crews. One of the transports was damaged by ground-fire, but the jump was successful, although some troops landed in the marshes nearby. The United States now had a total of 7,000 additional troops on the ground in Panama. As the airfield was secured and more forces were inserted, the field became a staging base for a series of offensive operations, including attacks on Panama Viejo, the PDF infantry at Tinajitas, and Ft. Cimarron.[22]

Just prior to H-Hour, in-country Army units were flown from Albrook AFS to the Pacora Bridge, some 15 km north of Tocumén/Torrijos airfield, to block a counterattack by the PDF Battalion 2000. As the Americans were landing near the Bridge a column of the Battalion 2000 was approaching. The troops quickly deployed and attacked. The first Panamanian vehicles were destroyed by M-136 Light Antitank Weapons,[23] and two AC–130s opened up with their 20, 40, and 105 mm guns. Within a few minutes, almost all the lightly armored vehicles of the Battalion 2000 were destroyed and the troops scattered. That was the end of the only Panamanian operation that could develop into a significant threat to the United States troops. Another battalion of paratroopers assembled at Tocumen/Torrijos was deployed aboard helicopters to Tinajitas at 0830, where two PDF units were swiftly destroyed. Two hours later a third battalion captured Ft. Cimarron, neutralizing the remnants of the Battalion 2000 (at a cost of one killed and several wounded): this PDF unit was under constant attacks by AC–130s during the night and lost many troops and almost all of its vehicles.

The Battle for *La Comandancia*

TF Bayonet, with the Panama-based 193d Infantry Brigade augmented by several stateside units, was assigned responsibility for the assault on *La Comandancia* as combat operations commenced. The *Comandancia* was the PDF headquarters and the seat of Noriega's power. Firepower from the AC–130s proved inadequate to penetrate the concrete floors of the building, permitting the PDF defenders to place United States forces under

A Congressional delegation inspects the remains of the Comandancia a few days after the action.

NORIEGA SURRENDERED ON JANUARY 3, 1990. THE DICTATOR WAS QUICKLY TAKEN ABOARD A WAITING H–60 HELICOPTER THAT FLEW HIM TO HOWARD AFB

heavy fire during the assault. The ground forces had to use all their organic firepower plus close air support from AC–130Hs of the 16th SOS to continue the advance. The Specters continued to fly orbits around their targets, concentrating the fire of all their weapons. Several times opening fire against PDF positions only meters away from United States troops, the gunship crews proved the effectiveness of their fire control system with troops in close contact. The heavy fire poured into *La Comandancia* from the air and the ground and substantially damaged the building. The Panamanian troops remaining inside *La Comandancia* and nearby houses had to be neutralized in a brutal battle, lasting until 1730.

Action at Patilla Airfield

Meanwhile, the Navy's SEAL Team 4 deployed from Rodman Naval Station to attack the small civil airfield at Punta Paitilla, a short distance from downtown Panama City. Their mission was to deny Noriega an escape route from Panama aboard his private aircraft.

The 48-man team landed on the coast immediately south of the civilian airfield just before H-Hour and moved towards the hangars at the end of the field. At the moment the SEALs were in position to attack Noriega's Lear Jet, they came under a heavy counterattack from PDF security forces and lost four killed in a short fire-fight. A quick redeployment of the SEALs neutralized the Panamanians guarding the hangar housing Noriega's aircraft; the aircraft was successfully disabled, shutting off this escape route.[24]

United States forces lost track of Noriega in the hours before the kickoff of JUST CAUSE, and he managed to keep one step ahead of his pursuers for several days. He finally took refuge in the Vatican Embassy on December 24. The compound was immediately surrounded by United States troops, and after protracted negotiations, Noriega surrendered on January 3, 1990. The dictator was quickly taken aboard a waiting H–60 helicopter that flew him to Howard AFB. There he was taken into custody by Drug Enforcement Agency agents and flown to Homestead AFB, Florida aboard an MC–130 of the 8th SOS.[25]

Civil Affairs Operations

As combat operations were quickly being wrapped up, actions turned to Civil Affairs (CA). The war plan designated the SOUTHCOM J-5, Brig. Gen. Ben Gann, USAF, as the Commander, Civil-Military Operations Task Force, and as operations commenced, the entire unified command J-5 staff was dedicated to the CA efforts. There had been essentially no CA expertise on the SOUTHCOM staff at H-Hour: one Army officer in J5 had been working CA staff actions on a part time basis. Most of the CA expertise in the United States military resided in the Army Reserve. These individuals were never mobilized, but many volunteered and subsequently deployed to augment active duty civil affairs personnel that arrived as part of the JUST CAUSE assault.

There were countless Civil/Military actions that had to be accomplished, from burying the dead to restoring operations at the civil airport. The extensive damage in the area around the *Comandancia* produced many refugees needing food and shelter. After the attack, there was a dire need to reestablish basic utility services, fire fighting, and police protection. Huge collection points were setup for refugees, and standard aid packages

were brought into Howard AFB on United States military missions.[26]

A USAF facility checker aircraft came in to recertify the navigation aids at the civil airport, which had been damaged during the airborne assault, in preparation for its reopening to commercial traffic. In the meantime, all air traffic had to land at Howard AFB. A number of countries wanted to perform humanitarian airlift and medical deliveries, as well as evacuate their embassy staffs and other nationals. These requests were handled on a case-by-case basis by the SOUTHCOM J5 staff with assistance from State Department personnel who quickly arrived from Washington. There was some political sensitivity with these missions, as there was concern that the flights were primarily evacuations, and the aircraft would bring in minimal medicines to justify landing as humanitarian aid flights.

CA reservist volunteers started arriving, and they relieved J-5 personnel of more and more of the CA duties. Not unlike the efforts at reestablishing Iraqi armed and police forces post Operation IRAQI FREEDOM, major efforts were aimed at establishing and training a police force that would assume some of the responsibilities of the PDF.

Operation JUST CAUSE was officially terminated on January 31, 1990. But the newly sworn in president and vice presidents had a dysfunctional and corrupt government apparatus; there was still a great need for United States help. The J-5 staff and mobilized volunteers had been assisting the Panamanians with civil affairs actions, but over the first couple of weeks after the invasion, it became clear that this arrangement had serious limitations. On January 17, a Military Support Group was stood up to coordinate the operations of the multiple agencies that were responsible for different aspects of getting Panama back on its feet. The new Panamanian government decided to form a national police force out of the remnants of the PDF. United States forces could provide advice and assistance to the police force as it attempted to control looting and restore order, but the advisability of using military forces to train foreign police forces was an open question. The operations from the conclusion of active combat operations until the redeployment of the remaining combat troops are today what we would call Stability Operations. Hindsight has shown the inadequacies of the planning and preparation for this phase of the operation; similar criticism has been consistently levied on the lack of planning for post-invasion operations in the wake of Operation IRAQI FREEDOM.[27]

THE PREDOMINANT ROLE ASSIGNED TO AIR POWER WAS AIRLIFT, AND MAC PROVIDED THE AIRLIFT THAT WAS NEEDED, SUPPORTED BY AIR REFUELING FROM SAC

In total, the United States suffered a loss of twenty-three troops during Operation JUST CAUSE; the PDF lost 314 killed, 124 wounded, and 5,800 captured; most of their aircraft and heavy military equipment was destroyed. Reliable estimates were about 200 civilians killed and 1,500 wounded during the operation.[28]

Assessment

Many have praised the Goldwater-Nichols Act as helping guarantee the success of this operation. General Stiner testified to the Senate Armed Service Committee on May 11, 1990, "there were no problems with ambiguous arrangements or units receiving guidance from multiple sources." It is true that even the Special Operations Forces were subordinate to General Stiner as the JTF Commander. But the ultimate goal of the Goldwater-Nichols Act was to promote not only cooperation, but efficient integration, capitalizing on the capabilities and strengths of each service. Its success at the operational level was therefore limited. This was planned as an Army operation, and was reflected in the organization, with an Army Corps assuming responsibility for planning and commanding the operation as a nominally joint task force without organic representation from the other services, as would have been the case in a true joint task force. The Army planners came up with Army solutions. This JTF organization led to limitations in the employment of air power reminiscent of the early days of World War II: the Air Force was to provide support (in the form of close air support) to the Army plan, not for ground and air forces being employed in an optimal, mutually supportive manner to accomplish strategic objectives. Another organizational deficiency was not all air operations were under General Kempf, the air component commander. In particular, special operations air forces were under the theater's Special Operations Component Commander despite their use in a far broader role than just special operations. The only forces directly under the air component commander were the small numbers of rotational and organic fighters. Air power could have been substantially supplemented by a carrier task force, although operational control issues could have been contentious. These problems would be solved to a greater degree than ever during DESERT STORM a few months later, but in December 1989, the ability of the Goldwater-Nichols reforms to solve problems of service cooperation and integration proved to be limited.

The predominant role assigned to air power was airlift, and MAC provided the airlift that was needed, supported by air refueling from SAC tankers. MAC successfully inserted the invasion forces, despite problems associated with short notification and adverse weather.[29]

The AC–130 gunships were ideally suited for the range of combat missions required in this operation—close air support and interdiction, but also reconnaissance and surveillance, and even offensive counterair. The minimal air defense threat, particularly at typical gunship operating altitudes; the gunship's large ammunition supply, its long on-station time, and the precision of its fire control system, allowed them to pulverize targets, while leaving adjacent civilian residences and businesses untouched.[30] The AC–130s demonstrated their effectiveness in applications beyond just special operations.

But broader uses of air power were clearly called for; there are examples where XVIII

The DENI (often referred to as the Panamanian FBI) building blasted to bits by AC–130 fire.

Airborne Corps planners called for ground force assaults where air power could have been effectively used with reduced risk for the ground forces. A more integrated planning effort could have led to different assignment of the combat tasks. A leading example is the attack on Rio Hato. During the October coup attempt, PDF units were airlifted from Rio Hato to Panama City to support Noriega. Planners, therefore, determined that merely blocking the Pan American Highway would be insufficient, and that the Rio Hato airfield and the PDF units would have to be attacked directly and neutralized. But since air supremacy was guaranteed, air action could have prevented any airlift of PDF forces to the capital. Even given that an airborne assault was to be accomplished, air forces could have been used to suppress the enemy air defenses and attack PDF barracks prior to the airborne assault. The attack on the *Comandancia* is another example where a more robust air attack could have shortened the battle. The 105 mm rounds from the gunships proved inadequate to penetrate the concrete floors of the *Comandancia*, and brutal fighting devastated the surrounding area, and U.S. forces were forced into a dangerous room-by-room search to extract the remaining PDF troops from the building. Another example where a ground assault was used was at Patilla airfield. The mission, accomplished with the loss of four sailors, was to eliminate Noriega's potential escape route by destroying or disabling his personal executive jet. An AC–130 could have easily destroyed or damaged the aircraft, and cratered the runway, achieving the mission objective of preventing any aircraft takeoffs.

RATHER THAN DESTROY THE PDF BARRACKS, THE F–117S WERE TO DROP THEIR WEAPONS NEAR THE PDF FORCES TO STARTLE AND CONFUSE THEM

The attack on Rio Hato also demonstrates the choice of the wrong weapon by the Air Force. F–117s flew their first combat mission, dropping 2,000 pound bombs. Rather than destroy the PDF barracks, the F–117s were to drop their weapons near the PDF forces to startle and confuse them immediately before the airborne assault by the Rangers. The F–117s were designed to be difficult to detect by radar, the type of aircraft that would be used against the most heavily defended targets on the first day of a conventional conflict (and were a year later, very successfully, in Iraq). This threat did not exist in Panama. It was still argued, however, that the F–117s were right for the task due to the precision of their targeting system. But, considering the air defense environment that prevailed, the flexibility afforded with a gunship in terms of loiter time, and ability to cope with real time target changes, would have made it a better choice for this mission. Its 105 mm rounds, while not providing the destruction of a 2,000-pound bomb, but with greater accuracy (at least pre-JDAM), could have either effectively attacked the PDF barracks or at least caused confusion before the paratroopers jumped. Gunships were present at Rio Hato and effectively suppressed the air defense threat and supplied close air support, but weren't in action until after the F–117 attack.

Operations in Panama after the end of combat resemble to some degree the post-invasion situation in Iraq. JUST CAUSE has been criticized for not taking enough time to plan for post-combat requirements. Panama had the advantage over Iraq of not being embroiled in internal strife between rival religious groups—still, there were countless civil affairs duties that needed to be accomplished, and little planning for their accomplishment. There was lawlessness in the streets, displaced persons, widespread damage, and no civil police authority. Dealing with these problems fell to the military, primarily the ground forces. The military was experienced and resourceful enough to make it up as they went along, at least to some point, but the scope of the problem was far less than in Iraq. The lesson of the need for adequate planning for this phase of the operation, and particularly the participation of numerous agencies beyond the military, was relearned in Operation IRAQI FREEDOM. ■

NOTES

1. Morrison, Samuel Eliot, *The Two-Ocean War*, Boston: Little, Brown and Company, 1963, pp. 108-21.

2. A Panamanian administrator, Fernando Manfredo, Jr., replaced the United States administrator early in 1990.

3. Jointness, or at least interservice cooperation, was outwardly manifested by assignment of all the trash pickup to the Army, the mail handling to the Air Force, and school bus operations to the Navy.

4. Interservice cooperation, let alone integration of service forces, has had a spotty record over the years. General Eisenhower forged a command at the theater level for the invasion of Normandy with land, sea, and air components, and a joint and combined staff, including an RAF deputy commander. There were considerable issues associated with the command and control of strategic airpower in the

months leading up to D-Day, with General Eisenhower as the theater commander assuming control of the bomber forces before the invasion. There were significant problems with the command and control of air power during both the Korean and Vietnam Wars; these involved both problems with Army theater commanders, and command and control with the Navy. An example of the latter was the system of "route packages" developed over North Vietnam that assigned responsibility for geographical areas of enemy territory to either the Air Force or the Navy. For an enlightening and thorough discussion of the range of command and control problems during the Vietnam War, see Momyer, William W., General, USAF, *Air Power in Three Wars*, Washington, D.C.: Government Printing Office, 1978, in particular, Chapter 3. Problems with joint operations, which extended beyond just command and control of airpower, came to a head with the invasion of the island of Grenada in 1983, which was plagued with fragmented planning and inadequate communications between service elements. This was the last straw that led to the Goldwater-Nichols Act. An historical summary of the attempts to achieve unity of command for theater warfare and air operations is contained in Cardwell, Thomas A, Colonel, USAF, *Command Structure for Theater Warfare: The Quest for Unity of Command*, Maxwell AFB, Ala.: Air University Press, 1984. See Chapter 2.

5. Nalty, Bernard C, Ed., *Winged Shield, Winged Sword, A History of the USAF*, Wash. D.C.: Air Force History and Museums Program, 1997, pp. 425-26. For a somewhat less damning perspective, see Dinges, John, *Our Man in Panama*, New York: Random House, 1990, a book-length analysis of Noriega's trafficking in drugs and arms.

6. Then they had to decide how to wear their rank insignia on their shirts. They adopted the Marine style of both rank insignia placement and rolling up sleeves.

7. Cole, Ronald H, *OPERATION JUST CAUSE, Panama*, Wash. D.C.: Joint History Office, Office of the Chairman of the Joint Chiefs of Staff, 1995, p. 24

8. Gunships were tasked by the 24th Composite Wing Air Operations Center at Howard. See 919th Special Operations Group, Duke Field, Fla. unit history, 1 Jul to 31 Dec 89, p. 9.

9. *Anything, Anywhere, Anytime: An Illustrated History of the Military Airlift Command, 1941-1991*, Scott AFB, Ill.: Military Airlift Command Office of History, 1991, p. 195

10. In a 1995 poll in the Panamanian newspaper *La Prensa*, 81.5% Panamanians answered the question "in general, how do you rate your liking for the United States and North Americans?" as "do like" or "don't know/didn't answer." Only 18.4% answered "do not like." Three quarters answered positively or neutrally to the question, "Do you think that the presence of United States bases in Panama enhances or tarnishes our image before other countries in the world?" See Falcoff, Mark, *Panama's Canal*, Washington, D.C.: The AEI Press, 1998.

11. Cole, p. 37.

12. This weapon is an anti-aircraft version of the basic Soviet 14.5 mm machinegun, introduced in 1949 and widely exported, and used in the Korea and Vietnam Wars. It has a range of about 5 miles. Information from The Federation of American Scientists website.

13. Donnelly, Thomas, Margaret Roth, and Caleb Baker, *Operation JUST CAUSE: The Storming of Panama*, New York: Lexington Books, 1991, pp. 90-91

14. Schultz, Richard H., *In the Aftermath of War: United States Support for Reconstruction and Nation-Building in Panama Following JUST CAUSE*, Maxwell AFB, Ala.: Air University Press, 1993

15. See 62nd MAW, McChord AFB, Washington, unit history, 1 Jul to 31 Dec 89. The 63rd MAW, Norton AFB, California, unit history for the same period reported "one-half inch of ice on their aircraft."

16. Nalty, pp. 431-32. Considerable detail describing the problems on the Pope ramp is in the oral history interview of Colonel James M Galyen, 21st Air Force DCS Operations by the Air Force Historical Research Agency.

17. The Defense Fuel Supply Center at Cameron Station, Va. arranged for 1 million extra gallons of JP-4 jet fuel to be delivered to Barksdale AFB. See Scott, Beth F, et al, *The Logistics of Waging War*, Maxwell AFB, Ala.: The Air Force Logistics Management Agency, 2000.

18. Quoted in Donnelly, pp. 56-57

19. See *Aerospace Daily*, issues of 5 April and 12 June 1990. Ironically, the barracks were essentially destroyed in the ground fighting and were subsequently bulldozed.

20. All of the following sources have somewhat differing accounts of the action at Rio Hato, and in particular, the attack by the F-117s: Nalty; Cole; Donnelly; Buckley, Kevin, *Panama*, New York: Touchstone, 1991; Warlock, A. Timothy, editor, *Short of War: Major USAF Contingency Operations*, Chapter titled *Intervention in Panama: Operation JUST CAUSE*, by William J. Allen, Wash. D.C.: Air Force History and Museums Program, 2000; Chinnery, Philip D., *Air Commando: Inside the Air Force Special Operations Command*, New York: St Martin's Paperbacks, 1994. The best personal account from the perspective of an MC-130 pilot and 8th Special Operations Squadron Commander is in Thigpen, Jerry A, Colonel, USAF Retired, *The Praetorian STARship: The Untold Story of the COMBAT TALON*, Maxwell AFB, Ala.: Air University Press, 2001.

21. An antitank weapon for airborne forces developed in the mid-1960s, it originally served in Vietnam stripped of its primary antitank missile equipment. Armament included a 152-mm main gun, a .50-caliber M2 machine-gun, and an M60 7.62-mm machine gun mounted with the main gun. It served in the U.S. Army inventory for 27 years. Information from www.olive-drab.com.

22. Donnelly, Chapter 10

23. A lightweight, self-contained, anti-armor weapon consisting of a free-flight, fin-stabilized, rocket-type cartridge packed in an expendable tube. The firer must be able to see and identify the target and estimate the range to it. The maximum effective range is about 1000 feet. Information from www.olive-drab.com.

24. Donnelly, p. 115

25. Nalty, pp. 437-38

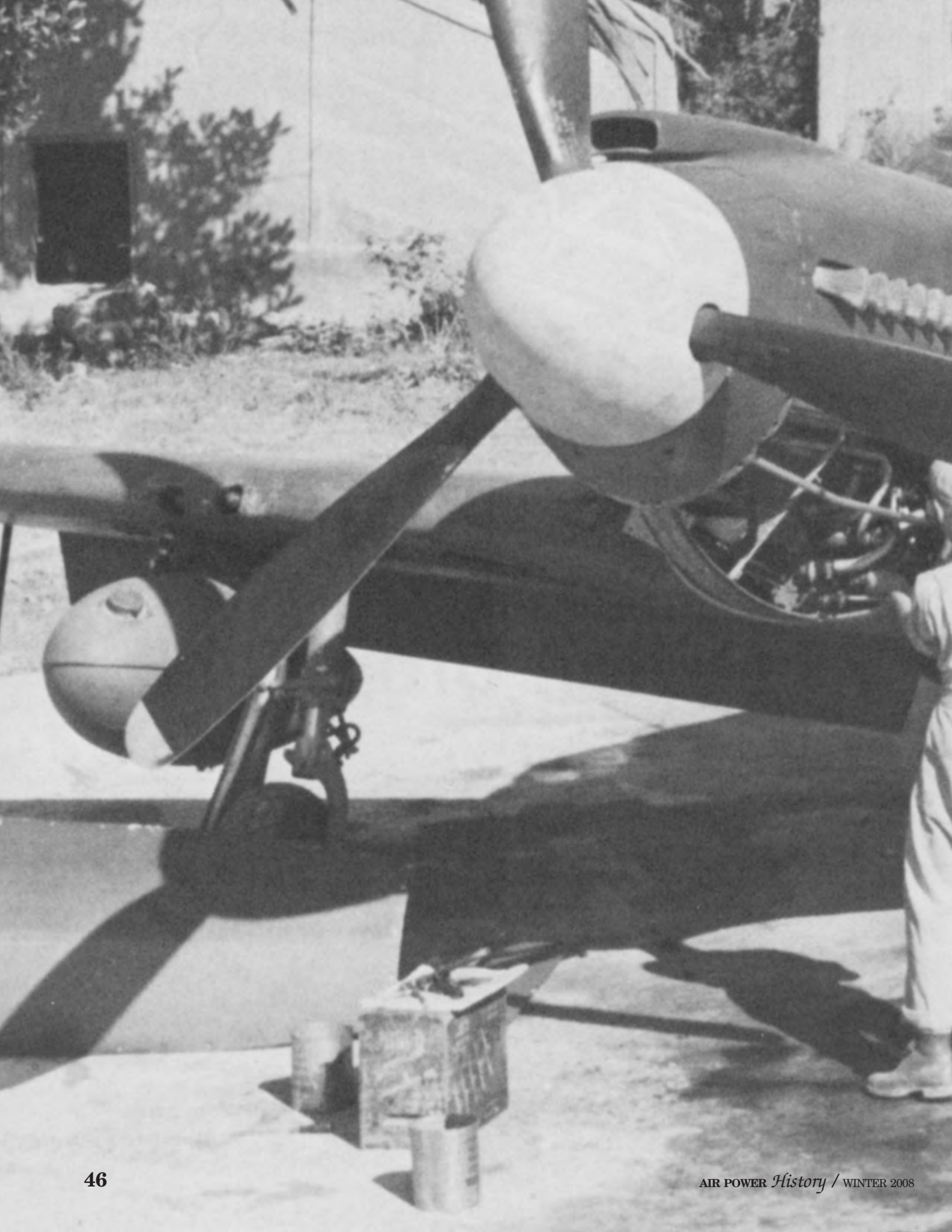
26. Military airlift missions delivered 3 tons of medical supplies, 10,000 blankets, sheets, and food during the period Dec 27 to Jan 3, 1990. Some of the contents of these standardized packages were seemingly incongruous, including substantial amounts of sugar and coffee. See Brunkow, Robert, *Toward The Air Mobility Command: A Chronology of Tanker and Airlift Events*, Scott AFB, IL: Air Mobility Command Office of History, 1994, p. 52

27. See Shultz's study, which deals specifically with the planning and conduct of the Stability Operations phase of the campaign

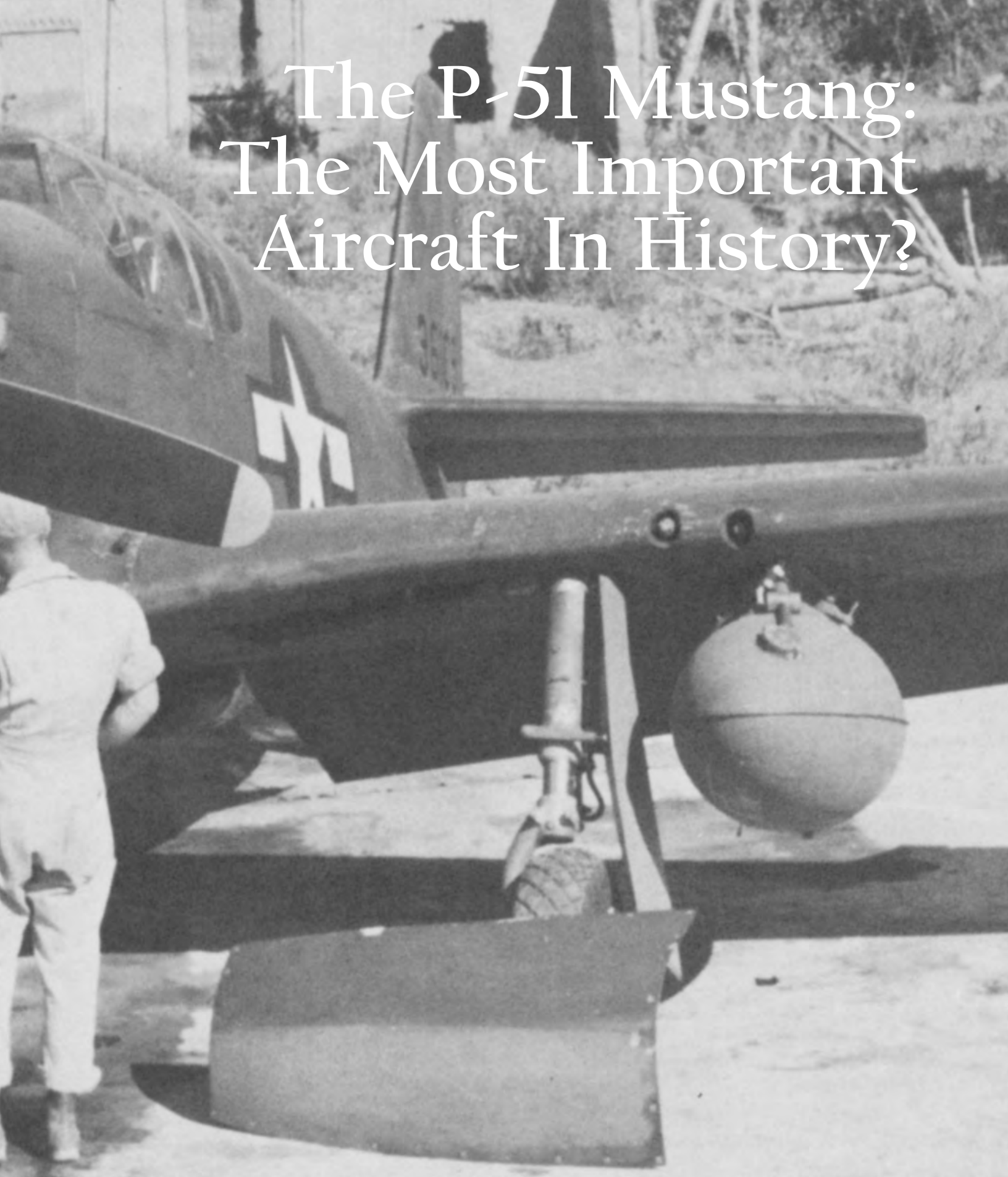
28. Nalty, pp. 438-39. Other sources cite somewhat but not radically different numbers.

29. MAC officially cites the following statistics from JUST CAUSE: 775 missions transporting 39,994 passengers and 20,675 tons of cargo to and from Panama. In addition to these totals, Special Operations units of MAC's Twenty-third Air Force flew 796 fixed and rotary wing sorties during the operation. See *Anything, Anywhere, Anytime: An Illustrated History of the Military Airlift Command, 1941-1991,* p 198. Nine aeromedical evacuation sorties were flown between Dec 20 and Jan 5, 1990, transporting 257 wounded troops. Over 100 SAC KC-135 and KC-10 tankers delivered 12 million pounds of fuel during 256 sorties. See Brunkow, pp. 51-52.

30. The 919th Special Operations Group unit history for the second half of 1989 also describes the effective use of the gunship's fire control system for reconnaissance, and cites an example of how a gunship crew used the aircraft's systems to avoid a friendly fire incident.



The P-51 Mustang: The Most Important Aircraft In History?



Marshall L. Michel

(Overleaf) An Allison powered P–51A—note that it was already capable of carrying external wing tanks. Note the small size of the low drag pylons. *(All photos, unless otherwise credited, are USAF photos.)*

Many historians credit the defeat of the *Luftwaffe's* fighter force prior to the Normandy Invasion to the combined effort of the frontline American fighters—the P–47 Thunderbolt, the P–38 Lightning, and the P–51 Mustang. Some support the view of Maj. Gen, William E. Kepner, of the Eighth Air Force Fighter Command, who wrote, "If it can be said that the P–38s struck the *Luftwaffe* in its vitals and the P–51s gave the *coup de grace*, it was the Thunderbolt that broke its back."[1] Still others tilt more toward the P–51, but no one has made the obvious leap to state that: *without the P–51 the American daylight bombing of Germany would have been impossible in the spring of 1944; the German fighter force would not have been decimated and the Allies would not have achieved air superiority over Germany. And without air superiority, D-Day would have been either postponed or delayed*.[2]

This makes the P–51 the most important aircraft in history. I define most important as (1) the aircraft that provided a major change in the direction of a major war and (2) one that was irreplaceable; no other aircraft could have provided this critical capability at that critical juncture.[3]

THE P–38s STRUCK THE LUFTWAFFE IN ITS VITALS AND THE P–51s GAVE THE COUP DE GRACE, IT WAS THE THUNDERBOLT THAT BROKE ITS BACK

The Counterfactual Argument

This author believes there is ample evidence to support the claim, but making the case requires a counterfactual—the assumption that the Merlin engine P–51 was not acquired by the Army Air Forces (AAF). While some reflexively dismiss counterfactual history, it is common. Any historian who makes causal claims generally includes a counterfactual, although it may be unidentified. Moreover, if the highly-acclaimed historian John Keegan can consider counterfactual history, this author feels free to do the same.[4]

The rules for counterfactuals will be honored. Only one will be used, and it will be plausible, since this counterfactual will be judged by the plausibility of the assumption that the Merlin engine P–51 was not acquired by the AAF. Those familiar with the P–51 story (told at the end of this article) know what Niall Ferguson calls the "probable unrealized alternative" of the Merlin powered version, or any version at all, not reaching the AAF was quite probable indeed.[5]

The Air War Over Europe in the Second Half of 1943

In late 1943 Germany's position in the west resembled England's position in August 1940. The Allies were well into a massive buildup preparing to invade France, but needed air superiority before considering an attack, and in late 1943 they did not have it. Allied tactical air forces could range relatively freely over occupied France within 150 miles of the UK, the combat radius of the Allies' most numerous fighter, the RAF Spitfire. But beyond that limit, lurking just over the German border, was much of the top tier of the *Luftwaffe* day fighter force arrayed against the American daylight strategic bombing offensive. Despite sustaining serious losses, the *Luftwaffe* had been able to maintain air superiority over most of Germany and they regularly slaughtered unescorted Eighth Air Force bomber formations. This situation had come about because, in one of the most costly technical and doctrinal misjudgments of the war, the Allies lacked a fighter with the range to escort the bombers into Germany. [6]

The AAF, counting on the seemingly heavy armament of its B–17s and B–24s, began its bombing campaign in Europe based on the doctrine that its bombers in close formation could fly deep into enemy territory without fighter escort. The AAF disregarded the experience of the *Luftwaffe* over England and of the RAF, which had discontinued unescorted daylight bombing early in the war due to heavy losses to German fighters. What the AAF did not learn from the British they learned from the Germans, and in the late summer and fall of 1943 the *Luftwaffe* shot to pieces the Americans' pre-war theory. The end came in October 1943, when Eighth Air Force Bomber Command flew four large unescorted bomber missions deep into Germany in seven days. During these four missions the command lost 148 bombers (and the 1,480 crewman on board), and had many bombers heavily damaged. For the rest of 1943, Eighth Air Force bombers avoided unescorted missions.

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The escorter escorted—a P–38 limping home from an escort mission with one engine out, an all to familiar occurrence.

THE MOST EFFECTIVE GERMAN ATTACKS WERE THOSE THAT BROKE UP THE TIGHT BOMBER FORMATIONS AND THEIR MUTUAL SUPPORTING FIREPOWER

According to Eighth Air Force, the most effective German attacks were those that broke up the tight bomber formations and their mutual supporting firepower, making them more vulnerable to fighter attack. The greatest danger came from single engine and twin engine fighters firing the spin-stabilized 248-pound *Wurfgranate* (WGr.) 210mm rockets carried in large, underwing tubes, a total of two for a single engine fighter and two or four for twin engine fighters. Though not particularly accurate and lacking a proximity fuse, the rockets were extremely effective. The eighty-pound warhead was time fused to detonate at between 600 and 1,200 yards, so the rockets were launched from well beyond the range of the bombers' .50 caliber machineguns. To inflict damage the rocket needed only to explode within 50 feet of the target and often an exploding or out of control bomber in a tight formation would damage or occasionally bring down adjacent planes. Additionally, even when the rocket missed, the large explosion inside a formation tended to make the bombers spread out.[7]

The second great problem for the bomber formations were the Germans' mass head-on attacks with single engine fighters. A large formation of fighters would fly a parallel course off to one side of the bomber formation outside the range of the defensive guns. After reaching a point about three miles ahead of the bombers, groups of the fighters peeled off in formation and swung around 180 degrees to attack head-on in rapid succession trying to destroy the bombers' flight deck, explode the bombs in the bomb bay or hit the oil tanks and/or wing fuel tanks. Mass was the secret to such attacks at the beginning of the strike and it was critical for the fighters to maintain some semblance of cohesion so the gunners could not concentrate on single aircraft. After each pass the formations would try to regroup to make another mass attack.[8]

With increased experience the German pilots refined their tactics and began to make their head-on attacks using either in trail "line astern" formations or with the entire unit spread out in a line abreast formation. More importantly, they moved from true "head on" horizontal attacks, which had made range estimation difficult, to attacking from about ten degrees above the horizontal, what American bombers crews came to call "12 O'clock High." This change greatly simplified the problem of estimating range and made firing somewhat similar to ground strafing. Like the rocket attacks, even when the head-on attacks did not score kills they forced the American formations to spread out to avoid collisions.[9]

The frustration for the American air leaders was that they knew that fighter escorts would easily eliminate these two threats. The large, heavy and high drag WGr rocket tubes made any aircraft carrying them slow, clumsy and almost helpless against fighter attack. The same was true with the mass head-on attacks—a few escort fighters could quickly and easily scatter the unwieldy mass formations as they maneuvered into position to execute the attack or tried to reform. The *Luftwaffe* knew this and its leaders wanted to keep most of its rocket armed fighters and large mass formations beyond the escorts' range and hammer the bomber formations when the escorts had to return to base. This was not as easy as it seemed—Goering and other political leaders wanted to engage the

A P–47 in England in late 1943. Note how close the centerline external tank is to the ground.

bombers at all points—but generally common sense prevailed and the *Luftwaffe* was able to hold its most deadly weapons for the part of the mission when the bombers were unescorted.[10]

The American Crisis: January –April 1944

IT WOULD NOT BE GERMAN AIRCRAFT LOSSES THAT DECIDED THE BATTLE, BUT THE DESTRUCTION OF THE *LUFTWAFFE* FIGHTER FORCE'S MOST IRREPLACEABLE ASSET, ITS PILOTS

At the beginning of 1944, the *Luftwaffe* was reorganizing, forming the *Luftflotte Reich* to provide better control of their fighter forces to counter the Allied attacks. They had also prepared for the expected invasion in the summer by setting up *Drohende Gefahr West,* a system to rapidly deploy fighters and fighter-bombers to new bases in France when the invasion came.[11] If the Germans had air superiority over their homeland, theoretically they would have been able to move aircraft in an organized fashion to the front.

The Allies needed real air superiority for a summer 1944 invasion, and for the AAF leadership the way to knock out the *Luftwaffe* was by bombing the major aviation industries, especially the aircraft and engine factories. This became Operation ARGUMENT, including a period known as "Big Week."[12] But there were numerous problems with attacking the aircraft and engine factories. Most of the ARGUMENT targets were located in central and southern Germany, between 400 and 550 miles from the Eighth Air Force bomber bases in England, well beyond the range of American escort fighters.[13] Additionally, events were underway that would make attacking the German aircraft and engine factories the wrong way to destroy the *Luftwaffe*. Albert Speer was on the verge of creating the "aircraft production miracle" which would vastly increase German fighter production early in 1944. By the middle of the year, Speer's changes in the way fighters were produced would guarantee that the *Luftwaffe* would have a continuous supply of new, modern fighters to face the American bomber formations. Thus, despite heavy losses in the air and on the ground, German fighter numbers were close to stable until June 1944.[14]

This meant the AAF would be operating at the beginning of 1944 with a flawed strategy. It would not be German aircraft losses that decided the battle, but the destruction of the *Luftwaffe* fighter force's most irreplaceable asset, its pilots.[15] It was especially important to reduce the small number of highly skilled German pilots, the "hawks"—pilots who scored, or had the potential to score, a very large number of kills.

Extensive research shows that in air-to-air combat the majority of those killed would be either low skill experienced pilots or, more likely, new pilots. It also shows it is more than just a cliché that surviving the first ten "decisive" combat missions increased a fighter pilot's chances of survival exponentially, and after about ten missions even pilots who would have not become multiple kill "hawks" were much more effective in combat. Also, it seemed not to matter what kind of combat missions the inexperienced *Luftwaffe* pilots flew. Fighter versus fighter combat was much more challenging and dangerous than attacking bomber formations, which required more courage than skill, but attacking bomber formations seemed to count towards making the pilots combat veterans. Thus, when attacking bomber formations, the pilots gained experience without having to engage in more dangerous fighter versus fighter combat.[16]

No matter what the potential of a new pilot to develop into a "hawk," before they gained the necessary combat experience they were highly vulnerable, and killing new hawks "in the nest" would deny the *Luftwaffe* replenishment of these top fighter pilots. While bombers' gunners shot down a certain number of fighters, because the gunners were usually hitting the German aircraft in the engine, the pilots often escaped unscathed and could bail out to fly again. In fighter versus fighter combat, in about two-thirds of the cases where a fighter was shot down the pilot was either killed or injured.[17]

It should be noted there is a myth that by the beginning of 1944 the *Luftwaffe* was short of fuel and this cut into both the number of aircraft it could fly and the number of pilots it could train.

This was not true. The Germans captured a large amount of fuel in Italy in the winter of 1943-1944 and had a special reserve of almost 120,000 tons. Fuel during the decisive battles of early 1944 simply was not an issue.[18]

WITHOUT THE P–51, EIGHTH AIR FORCE WOULD NOT ONLY HAVE HAD TO EXECUTE A FLAWED STRATEGY, BUT WOULD ALSO HAVE HAD TO TRY TO EXECUTE THE STRATEGY WITH FLAWED FIGHTER ESCORTS

The Counterfactual Year, 1944: Air-to-Air Combat without the P–51

In the counterfactual early 1944 without the P–51, Eighth Air Force would not only have had to execute a flawed strategy, but would also have had to try to execute the strategy with flawed fighter escorts because neither the Republic P–47C/D *Thunderbolt* nor the twin-engine Lockheed P–38H *Lightning* were up to the task. The P–47 had arrived in England in late 1942 and its defining characteristic was its huge size, the result of a large and complicated turbo supercharger system whose 60 feet of ductwork made the fuselage very deep. [19] The system gave the Thunderbolt an empty weight of 9,900 pounds, compared to the Spitfire IX's 5,600 pounds, the German Bf 109G's 5,800 pounds, and the FW-190's 7,000 pounds.[20] The P–47's size and weight meant that at low and medium altitude it was generally inferior in acceleration, turn rate, roll rate, and especially climb rate to the two main single engine German fighters. Initial mock dogfights between Thunderbolts and Spitfires confirmed these feelings. One P–47 pilot called the P–47 an "air inferiority fighter," and remembered "we lost four Thunderbolt pilots in rapid succession, spinning in from low level, while trying to match Spitfires in turns. In the end our headquarters issued an order banning mock dog fighting in Thunderbolts below 8,000 feet."[21] Nevertheless, after considerable initial disenchantment, as the American pilots flew the P–47 more and more they found that that at 30,000 feet and above the P–47's turbo supercharged engine allowed it to dominate all German fighters.[22]

The first P–47Cs that arrived in England did not have the racks or plumbing for external fuel tanks, a reflection of the AAF's disinterest in escort fighters. The P–47 was especially poorly designed from this point of view, because its fuselage was so deep and close to the ground there was limited ground clearance for an external belly tank. It took several months to install the plumbing and rack for even a single belly tank for the P–47, and then there were delays in getting the external tanks into production and producing sufficient quantities.[23] It was August 1943 before the P–47 was finally fitted with the shackles and plumbing to carry an effective jettisonable centerline extra fuel tank.[24]

Once the belly tank was mounted, the P–47 began to become useful for escort missions. However, because the P–47 got less than 1.8 mpg, so even with the centerline tank its combat radius was only about 350 miles, just barely enough to reach Germany.[25] Still, initially the P–47s with belly tanks wrong footed the *Luftwaffe* and the Thunderbolts wrought great destruction on the German heavy fighters, especially the twin engine Bf 110s. The *Luftwaffe* countered the longer range of the P–47s by the simple expedient of holding off its heavy fighters until the Thunderbolts had to leave the bombers because of range limitations.[26]

The seemingly simple task of fitting wing tanks to the P–47 was another issue. Fitting external fuel tanks to the wings required extensive structural modifications because the wing out to the joint was taken up with large landing gear and four .50 caliber machineguns and was not designed to carry external loads. It was not until 1944 when a later model P–47 arrived with a reinforced wing able to carry wing tanks and bombs.[27] But once the wing was reinforced, yet another problem arose. The landing gear and the P–47's four guns per wing meant the pylon had to be mounted where the ailerons began. Therefore, it had to be very deep so as not to interfere with aileron travel or hit the aileron when the tank was jettisoned. This resulted in a large, non-jettisonable pylon that was streamlined but still produced a great deal of drag.[28]

One of the secrets to achieving maximum range was "nursing" the throttle and flying at slow speed, but because of the P–47's slow acceleration it had to fly at relatively high speeds and consume more fuel. This kept the Thunderbolts from flying a slow speed, weaving pattern close to the bomber formations. While many fighter pilots thought avoiding such close escort was a good idea, as the campaign developed the most effective method of escorting the bombers proved to be a combination of close, weaving escorts and far ranging fighter sweeps.[29]

The P–38 Lightning

The other escort fighter was the twin engine P–38H Lightning, which had first arrived at Eighth Air Force bases in England in August 1942. The P–38H was fast, had excellent acceleration, and very good range with its internal fuel and two external 150 gallon tanks, but less than two months after the P–38s arrived in England all the P–38 groups were sent to North Africa to support operations there. [30] During its time in North Africa, the P–38's combat record had been spotty. It could escort the bombers long distances, but it had difficulty coping with well flown German single-engine fighters. On August 25, 1943, just before the Lightnings were recalled to England, thirteen P–38s were shot down in dogfights with Bf 109s from one of the top German fighter squadrons, *Jagdgeschwader* 53, against no German losses. The next week ten P–38s were shot down in dogfights with Bf 109s, with only a single German loss.[31]

Despite doubts about the P–38's performance, by the middle of 1943 Eighth Air Force needed all the long range escort fighters it could get. Like the P–47, the P–38 got less than 1.8 mpg, but with its two large external tanks it had a combat radius of about 450 miles, which would allow it to fly deep into Germany and cover many of the important targets.[32] In September, one group of P–38s went from the Mediterranean to Eighth Air Force and it was

A late model P–47D. Note the large, high drag wing pylons for fuel tanks or bombs.

ON JANUARY 30, 1944, ABOUT A QUARTER OF THE P–38s ESCORTING A FORCE OF BOMBERS HAD TO RETURN FOR ENGINE PROBLEMS, AND ON A DEEP PENETRATION MISSION FEBRUARY 4, 1944, ABOUT HALF THE P–38 ESCORTS ABORTED

soon followed by three other P–38 groups.[33]

When the P–38s arrived in England, the cold, damp skies over Europe exposed a number of new, major performance problems that had not come to light in North Africa. Its Allison engines were unreliable at high altitudes; the main problem was the limited cooling ability of the leading edge intercoolers for the compressed air from the supercharger entering the carburetor. The result was when the P–38s were cruising and they had to rapidly apply full combat power the surge often resulted in seizures, thrown connecting rods and/or explosions.[34] There was another, opposite problem with the oil—it became too cold. Oil consumption was quadrupled when P–38s operated at escort mission altitude, 25,000-30,000 feet, and the thickened oil in the turbo superchargers often led to their running away and/or failing.[35] Throttle stops were installed to keep the engines below maximum power, but often quickly removed by the units. On one of the early deep penetration raids on January 30, 1944, about a quarter of the P–38s escorting a force of bombers had to return for engine problems, and on a deep penetration mission February 4, 1944, about half the P–38 escorts aborted.[36] Since the problems increased exponentially above 30,000 feet, the P–38Hs had to operate below that altitude.[37] There were no fixes in sight for the engine problems, and this meant that P–38s were always vulnerable to attack from above, especially from Bf 109Gs, which were excellent at high altitude.

Additionally, the P–38's cockpit heat was totally inadequate, and when P–38s arrived over the combat area after two plus hours at altitude, it was noted that "pilots were so numb that they were too miserable to be of any real value; to make matters worse, they didn't particularly care."[38] The P–38's large size and distinctive silhouette was another disadvantage. It could be identified at long range, and this allowed German fighters to take defensive measures to avoid the P–38s or climb above them and set up for an attack, depending on the circumstances.[39]

All of these problems appeared before the engagements even started. Once the P–38s were in a fight, several other disadvantages hindered their ability to shoot down single engine German fighters. The P–38's maneuverability was characterized by a very tight turning circle when using its maneuvering flaps, but a very slow roll rate, which became slower the higher the speed because of the unboosted controls and the large size of the aircraft.[40]All models of the P–38 had a control wheel rather than a control stick, which added to the problem.[41]

Another disadvantage in a dogfight was the P–38's inability to dive faster than Mach .65, while the Bf 109 and FW-190 could dive at Mach .75, which gave the Germans a 50 mph speed advantage in a dive from 30,000 feet.[42] When single engine German fighters were attacked by P–38s they would roll into a tight turn then, when the P–38 began to cut inside the turn, the German fighter would simply reverse his turn and dive, maneuvers which the P–38 could not match.[43] The combat experience of the 20th Fighter Group, the second of the P–38s groups in theater, tells the story. The group began to fly missions in late December 1943 and in the next ninety days the 20th claimed 52 enemy aircraft but lost 54. By July 24, 1944, the group lost 87 pilots and only claimed 89 German aircraft in the air.[44] It should be noted the P–38 kills were "claimed," not confirmed by German records. P–38 pilots tell of taking up defensive circles when attacked by German single-seaters, and it is small wonder *Luftwaffe* general and 100 plus kill ace Adolph Galland compared the P–38 to the Bf 110, the *Luftwaffe* twin engine fighter that faltered badly in the Battle of Britain when it had to fight British single seat fighters.[45]

An 8th AF P–47 taxiing out in the fall of 1943—note how close the belly fuel tank is to the ground and the lack of wing pylons for fuel tanks.

Thus, in the non-P–51 counterfactual world, Eighth Air Force would have begun 1944 trying to fly daylight bombing missions deep into Germany with a small number of P–38 escorts, clearly inferior to German single seaters. A graphic example of the fate of bomber formations escorted only by P–38s took place on February 25, 1944, when a formation of 116 bombers from Fifteenth Air Force attacked Regensburg. Despite an escort of 96 P–38s, 41 bombers were lost—almost 40 percent.[46] The bomber loss rate for P–38 escorted missions deep into Germany would have certainly been over 20 percent, and might even have come close to the AAF's planners' worst fears of 200 bombers (and 2,000 crewmen) per mission.[47] Eighth Air Force might have had enough bombers and crews to accept such losses, but this loss rate would mean that the odds were well against a bomber crew completing its allotted 25—later raised to 30 missions. From a morale standpoint alone this was clearly unacceptable, not to mention that the loss of so many aircraft and aircrew would be intolerable in the U.S., where heavy bomber losses were already a sore point.[48] Also, given their inferior performance, the P–38 groups would certainly have suffered heavy, perhaps unacceptable, losses. The end result of having the bombers escorted by only P–38s would have given Eighth Air Force three unpleasant choices—not flying bombing missions to the major targets in Germany, flying them only rarely, or flying the full number of missions and taking huge losses.

THE PRE-D-DAY AIR PLAN CALLED FOR EIGHTH AIR FORCE AND RAF BOMBER COMMAND BOMBERS TO SWITCH THEIR ATTACKS TO GERMAN TACTICAL TARGETS IN FRANCE IN APRIL 1944

Timing was a critical issue. The pre-D-Day air plan called for Eighth Air Force and RAF Bomber Command bombers to switch their attacks to German tactical targets in France in April 1944. Thus, April was the decision point for determining if the Allies had air superiority. In the non-P–51 world, if Eighth Air Force turned to bombing targets in support of the invasion in April, this would have left the *Luftwaffe* fighter force in Germany and its experienced pilots largely intact, and Allied planners would have had to consider the possibility the *Luftwaffe* might not be defeated by the invasion date. This would have forced a choice between invading without the desired level of air superiority, or postponing the invasion until air superiority was achieved.[49]

Without the pressure of defending against bombing raids deep into Germany, the *Luftwaffe* would have been able to husband its pilots and train more. It would have had a more effective force and many more options after D-Day to confront Allied air power. Given the large numbers of airfields the Germans had constructed in France, the Allies would have been faced with the possibility that large numbers of German aircraft manned by capable pilots would move forward to contest Allied air operations over the battlefield on D-Day.

It was not until the spring 1944 that new P–47D models began to arrive that had modifications that provided a marked increase in performance, notably water injection and a paddle bladed propeller, and more importantly finally plumbed for extra fuel tanks on the wing.[50] By early 1944, model P–38Js with power boosted controls also arrived, but the J did little to solve the other problems.[51] Nevertheless, beginning in April 1944 the two might have been truly effective escort fighters, and the combination of the two might have been available to escort the bombers and knock out the German fighter force.[52] The problem was it was too late.

Another factor would have been the impact on the oil campaign that began on May 12, 1944. If air superiority had not been obtained by April 1944, the bombing campaign would almost certainly have continued against German aircraft factories and airfields and/or switched to D-Day targets. This could have delayed for months the beginning of the devastating oil campaign.[53]

The Real World of the P–51

Fortunately, because of a serendipitous series of events, the P–51 was developed and survived. It was a private response by North American Aviation in April 1940 to an RAF Purchasing Commission request to license and produce one of the standard

A beautiful study of one of the two RAF Mustangs taken from the British production run and evaluated by the USAAF. It has RAF camouflage and the six position RAF roundels replaced by USAAF insignia.

NORTH AMERICAN WAS ALLOWED TO DESIGN AND BUILD THE P–51's ANCESTOR, THE NA-73, …DUBBED THE MUSTANG BY THE RAF… WHEN THE MUSTANG FIRST FLEW IN OCTOBER 1940, IT DEMONSTRATED THE PROMISED SUPERIOR PERFORMANCE

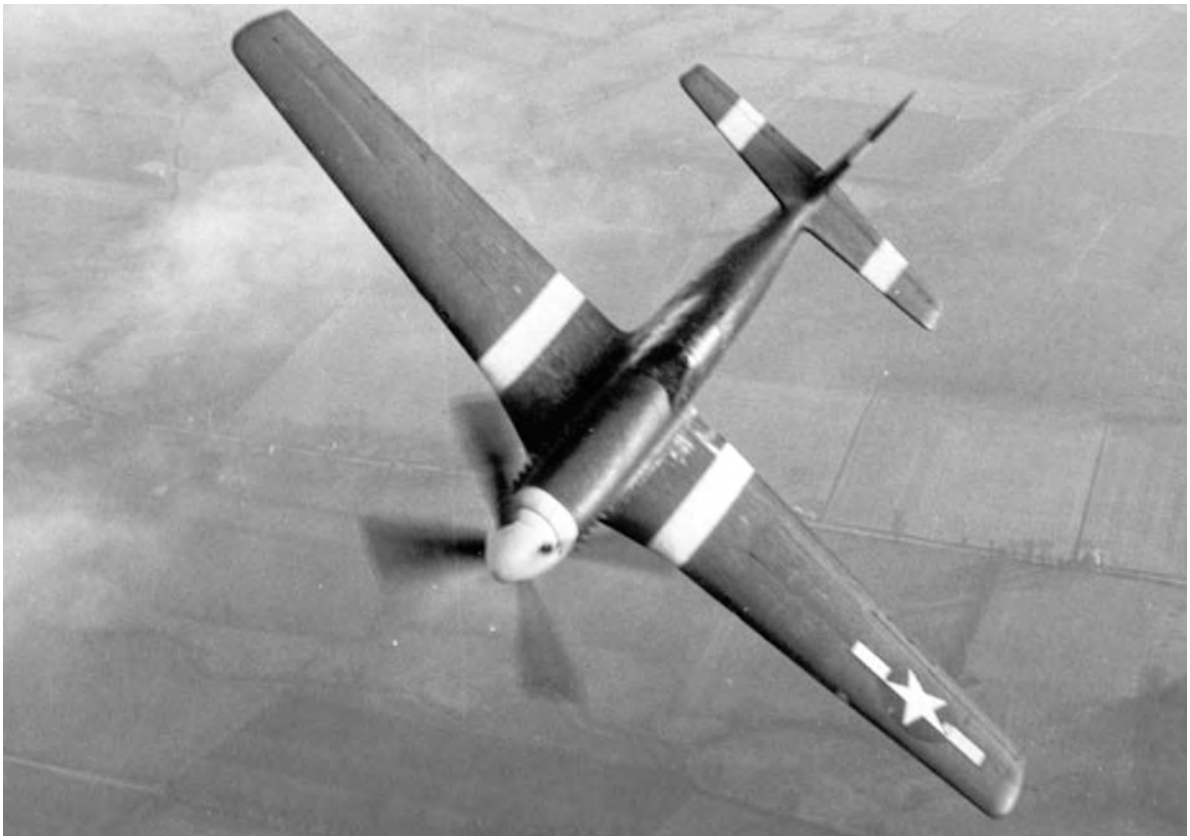
Air Corps fighters, the Curtis P–40. North American, anxious to move into the design business, offered to design and build a far superior fighter in less than 120 days.[54] The Army Air Corps (AAC) must have been dismayed at North American's nerve, especially since the purchase of more P–40s would cut their unit cost to the AAC. This was the first "choice point," and those familiar with bureaucratic operations can see that the "paper Mustang's" future must have hung by a thread. The AAC could have easily insisted the RAF buy the Curtis fighter, but it did not. North American was allowed to design and build the P–51's ancestor, the NA-73, and the British were permitted to buy 320 NA-73s, dubbed the Mustang by the RAF, and in September 1940 the RAF ordered another 310 Mustangs. When the Mustang first flew in October 1940, it demonstrated the promised superior performance and the British bought 150 more.

The RAF received the first Mustangs in October 1941, and once in service the Mustangs proved outstanding. They were thirty miles per hour faster than the standard RAF fighter, the Spitfire V, with twice the range, so in late 1941 the RAF ordered another 300. By summer 1942 fifteen RAF squadrons were flying tactical strike/reconnaissance missions in their Mustangs, photographing German beach defenses, attacking targets of opportunity, especially transportation, and generally probing German defenses. On July 27, 1942, sixteen RAF Mustangs flew a long-range reconnaissance mission to photograph the Dortmund-Ems Canal, the first time Allied fighters had penetrated German airspace.[55] On August 19, four Mustang squadrons provided tactical reconnaissance for Operation *Jubilee*, the "invasion" of Dieppe, and acquitted themselves well at low altitude against the new German FW-190s.

As the Mustangs were being delivered to the RAF, two were given to the AAF for testing. They were designated as P–51s, and the American test pilots filed enthusiastic test reports. When the RAF Mustang production line ended in 1942, one AAF general remembered "not having anything to do with the design, growth, and tests of the Mustang, [the Army Air Forces], looked with disfavor on the aircraft, but now that this thing had been built, and to avoid sticking our nose out too far [by ignoring the test reports], we said 'maybe there is some use for this aircraft.'"[56] The last twenty RAF Mustangs were taken by the AAF and fitted with two cameras for tactical reconnaissance work. Rather than let the line die, North American proposed a dive-bomber version of the Mustang for the AAF, the A–36, with dive brakes and wing shackles for bombs. The AAF ordered 500, and then realized it was good enough to be put in AAF fighter units and placed a second order for a fighter version, the P–51A, in August of 1942.[57] The P–51A, fitted with attachments for bombs and plumbed for drop tanks, was a considerable improvement over the P–40 for the low altitude fighter-bomber and tactical reconnaissance roles, but the P–51A's Allison engine with a one-stage, one-speed supercharger meant it could not compete at altitude with the Lockheed P–38 and Republic P–47, the main AAF fighters.[58]

The RAF's Air Fighter Development Unit (AFDU) tested the Mustang and found, as expected, the performance of the Allison engine dropped off above 15,000 feet, but it was so fast and maneuverable the AFDU invited a pilot from Rolls-Royce, Ronald Harper, to fly it. Harker took a brief flight in the Mustang in April 1942 and realized that what it needed was the installation of the Spitfire's Rolls Royce Merlin engine with a two stage supercharger. In August 1942 the RAF began the "Mustang X" program to re-engine a few Mustangs with the Merlin. The trials were completed at the end of December 1942 and the reengined fighter's performance, especially at high altitude, was spectacular.

Despite the tests, the RAF could not proceed with the project because Rolls Royce's Merlin production was already allocated to Spitfires, Lancasters, and Mosquitoes, but North American had been had been fully briefed by Rolls Royce on



The War Winner—the Merlin powered P–51B.

THE P–51Bs ... COULD CARRY ABOUT 400 GALLONS OF FUEL, [AND] THE P–51B GOT 3.3 MILES PER GALLON AS OPPOSED TO LESS THAN 1.8 MPG. THIS LOW RATE OF FUEL CONSUMPTION GAVE THE P–51 A COMBAT RADIUS OF WELL OVER 700 MILES

the Mustang X project and had had received authorization to install Merlin engines imported from England into two P–51s.[59] North American hoped to sell the Merlin P–51s to the AAF, but how would the AAF react when the company had the temerity to suggest that a British originated fighter with a British Merlin engine would be much superior to the P–47 and P–38? As the American Assistant Air Attaché in the London embassy noted, "Sired by the English out of an American mother, the Mustang has no parent at Wright Field to appreciate and push its good points."[60]

This was the second "choice point.' Even though the American Packard Motor Car Company had a license to build the Merlins, given the commitment to the P–38 and P–47 as the AAF's air superiority fighters the Mustang could easily have been dropped as surplus because of the "Not Invented Here" syndrome and the Merlins used to reengine the P–38.[61] Still, one more time, the P–51 survived.

The first Packard Merlin-powered Mustang, the XP–51B, flew in late 1942 and the increase in performance was even greater than that achieved with the British Mustang X. The Merlin's two-stage supercharger generated over 400 more horsepower than the Allison at 30,000 feet and made it over 100 mph faster than the Allison-powered P–51 at that altitude, and the rate of climb was almost doubled. It also had longer range on internal fuel than the P–47 had with its centerline fuel tank, and the P–51B, unlike the P–47, was plumbed for external wing fuel tanks—and on small shackles that produced virtually no drag. Soon an 85 gallon fuel tank was installed behind the pilot and gave it even longer range.[62]

The AAF quickly ordered them in quantity and the first production P–51B flew on May 5, 1943. But there was one last hurdle—because of its ancestry the first P–51Bs were initially assigned to the 354th Fighter Group in Ninth Air Force for tactical ground attack/reconnaissance. Fortunately, by the time the P–51Bs began to arrive in England in late 1943, the air war had changed dramatically as the P–47s and P–38s had shown they were inadequate for escort missions. The 354th and following P–51 groups were quickly attached to Eighth Air Force for bomber escort missions, where they had an immediate impact. In another fortuitous bit of timing, the efforts to procure external tanks for the P–47s had, after many fits and starts, resulted in enough external fuel tanks to equip the P–51Bs as they flooded into the theater.[63]

The P–51Bs that arrived in England could carry about 400 gallons of fuel, almost as much as the much larger P–47, but the P–51B got 3.3 miles per gallon as opposed to less than 1.8 mpg.[64] This low rate of fuel consumption gave the P–51 a combat radius of well over 700 miles, far enough to reach any target the bombers could. Additionally, unlike the P–38 and P–47, the P–51B's performance was superior to all German fighters. The P–51 was 30 to 70 miles per hour faster than any German piston engine fighter and had better acceleration, while its maneuverability, dive speed and climb rate matched or exceeded anything the *Luftwaffe* could offer.[65] Its acceleration offered another benefit—it could conserve fuel by flying slowly enough to provide close escort for the bombers, and then accelerate into an engagement.

In the first few months of 1944, the P–51s were

WITH THE P–51s ESCORTING THE BOMBERS ALL THE WAY TO THE TARGET THE GERMANS NO LONGER HELD THEIR FIGHTERS BACK UNTIL THE ESCORTS LEFT

able to lead the destruction of the German fighter force. Early in 1944 Mustangs were just 10 percent of the escorts, but scored 30 percent of the kills.[66] As an example of how the P–51 impacted air-to-air combat results, the 4th Group had about 75 kills in P–47s from March 1943 to February 1944 when they received P–51s. By mid-March 1944, the group had scored its 400th victory—350 in a month and a half in P–51s compared to the 75 in eleven months in the P–47.[67]

As more and more of the Mustangs were in action, German fighter losses were typically at least 10 percent of the fighters they sent up on a given day, and sometimes the losses rose as high as 40 percent. The critical blow to the *Luftwaffe* was the loss of over 1,000 fighter pilots from January to April 1944, including 28 with more than 30 kills and eight with over 100. On a mission to Augsburg, the P–51s marked the end of the greatest German threat, the rocket armed, twin-engine fighter, when they shot down 23 of the 77 that were airborne. One unit, III/ZG 76, was disbanded after this mission and the two engine rocket fighters were only used in the future against rare unescorted bomber formations.[68]

By March 1944, P–51s were escorting the bombers all the way to Berlin, and the Mustang's long range served another purpose. The flight routing of the fighter escorts could now be planned to maximize endurance in a "relay system," called "phased escort." The P–47s and P–38s escorted the bombers the first part of the way to the target then, when the P–51s arrived to take over the deep escort, the P–38s and P–47s dropped down and attacked German fighters as they took off and landed, then strafed German fighter airfields.

With the P–51s escorting the bombers all the way to the target the Germans no longer held their fighters back until the escorts left, since the escorts never left, and this gave the P–47 a new lease on life. Once the German fighters began to attack all along the route, it gave the short ranged P–47s more of an opportunity to engage—an opportunity they would not have had if there had been no P–51s —this has led many to conclude the P–47 was a much more effective air-to-air fighter than it in fact was. By the end of May the *Luftwaffe* fighter pilot force was decimated, the success of D-Day was assured, and P–51 was, directly or indirectly, almost entirely responsible. ■

NOTES

1. *The LONG REACH - Deep Fighter Escort Tactics* May 29, 1944, (VII Fighter Command), p. 3. Although interesting "this is a deeply flawed report," skewed towards the P–47. Almost unbelievably, of the fighter leaders interviewed 17 flew P–47s, four flew P–38s, and only three flew P–51s. Nonetheless, by May 1944 the P–51 was recognized as the premier escort fighter and had taken over almost all the deep escort duties.

2. There are numerous references to the need for air superiority for D-Day. In a message to the commanding generals of Eighth and Fifteenth Air Forces on Dec. 27, 1943, General "Hap" Arnold pointed out the need for air superiority, saying, "Overlord and Anvil will not be possible unless the German Air Force is destroyed…this is a MUST." (Wesley Craven and James Cate, Eds. *The Army Air Forces in World War II: Volume III, Europe: Argument to V-E Day.* Washington, D.C.: Office of Air Force History, 1983, p. 4). {Hereafter, Craven and Cate, Vol. III.] There was also a political dimension. The thought of postponing the invasion of France would not have disturbed a number of political and military leaders in the Allied high command. These included RAF Air Marshal Arthur "Bomber" Harris, AAF General Carl "Tooey" Spaatz and the other the RAF and AAF devotees of strategic bombing who believed the strategic bomber could win the war by itself. Not invading the continent was also attractive to many British politicians who wanted to avoid the possibility of a huge number of causalities. (Craven and Cate, Vol. III, pp. 30-31).

3. It could be argued that another aircraft had a similar impact, the Japanese Navy's Mitsubishi A6N *Reisen* (Zero). A formidable argument could be made that without the Zero the Japanese would not have attempted war against the U.S. in the Pacific, certainly not in the form it took. Interestingly, while both were relatively outstanding performers, the critical capability they both provided was long range.

4. John Keegan, "How Hitler Could Have Won the War: The Drive for the Middle East, 1941," in Robert Cowley, ed., *What If? The World's Foremost Military Historians Imagine What Might Have Been* (New York: Berkley Trade, 2000), pp. 295-306.

5. Niall Ferguson, "Introduction: Virtual History: Toward a 'Chaotic' Theory of the Past," in Niall Ferguson, ed. *Virtual History: Alternatives and Counterfactuals*," (New York: Basic Books, 2000) p. viii.

6. This is well documented, but one should note the idea that a fighter could not combine long range and excellent performance was not limited to the American air leaders. See John Terraine, *A Time for Courage: The Royal Air Force in the European War, 1939-1945.* Appendix G, "Sir Charles Portal and the long-range fighter question (New York: MacMillan, 1985), pp. 703-4.

7. 3d Bombardment Division, Office of the A.C. of S., APO 634, "German Fighter Tactics against Flying Fortresses," Nov. 11, 1943. For the WGr 21, see Alfred Price, *World War II Fighter Conflict* (London, Macdonald and Jane's, 1975) [hereafter Price, *Fighter Conflict*].

8. Craven and Cate, Vol. III, p. 62. For a diagram of these attacks, see Price *Fighter Conflict,* pp. 151-52.

9. Donald Caldwell and Richard Muller. *The Luftwaffe over Germany: Defense of the Reich. (*London: Greenhill Books, 2007), p. 132 [hereafter Caldwell, Defense]; Craven and Cate, Vol. III, p. 75.

10. Werner, Gerbig, *Six Months to Oblivion: The Eclipse of the Luftwaffe Fighter Force*, (New York: Hippocrene Books, 1975), pp. 16-18.

11. Caldwell, *Defense*, pp. 141-43.

12. Craven and Cate, Vol. III, pp. 30-31.

13. In fact, the only Big Week objective within range of the P–47 was Diepholz—and that, just barely. Some of the Eighth Air Force Big Week targets were Brunswick, Halberstadt, Bernberg, Aschersleben, Leipzig, Schweinfurt, Furth, Stuttgart and Augsburg, all well beyond the P–47's range. Craven and Cate, Vol. III, *pp.* 30-31.

14. Williamson Murray, *Strategy for Defeat: The*

Luftwaffe 1933-1945 (New York: Chartwell Books, 1986), p. 228, Table LXVI: German Aircraft Strength, [hereafter Murray, *Defeat].*

15. This is discussed at great length in Stephen L McFarland and Wesley Phillips Newton. *To Command the Sky: The Battle for Air Superiority Over Germany 1942-1944,* (Wash. D.C.: Smithsonian Institution Press, History of Aviation Series, 1991), p. 17, [Hereafter McFarland].

16. "Decisive" means a mission where a participant is shot down. This is well documented with data from World War II, the Korean War, and the Israeli side of various Middle East Wars. For a good account, see "Feasibility Study to Predict Combat Effectiveness in Selected Roles: Fighter Pilot Effectiveness, ARDA Contract Study MDA 903, 76 CO169, MDC E1643, St. Louis, Missouri: McDonnell Douglas, Apr. 29, 1977, pp. 4-1 through 4-13,[Hereafter "Effectiveness"].

17. Report, Gruppe 1c (Intelligence) to General Galland, Luftwaffe General of Fighters, quoted in Alfred Price, *Battle Over the Reich*.(Charles Scribner's and Sons, New York, 1973), p. 130. If one looks at fighter gun camera film, the geometry for this fact is easily understood. Fighters attack from behind where the victim has little protection.

18. Murray, *Defeat*, p. 201.

19. Price, *Fighter Combat,* pp. 70-71.

20. Weights from William Green's *War Planes of the Second World War, FIGHTERS*, (London: Macdonald, 1960). P–47, *Volume Four,* p. 173; Spitfire IX, *Volume Two,* p. 106; FW 190, *Volume One,* p. 100; Bf 109G, *Volume One,* p. 157.

21. http://www.aviation-history.com/republic/p47.html, "One Pilot's Initial Reaction To The P–47 Introduction."

22. http://www.lanpartyworld.com/ww2/alliedair.htm, Interview with Col. Francis "Gabby" Gabreski from General Dynamics *Code One* magazine, date unknown.

23. Additionally, the P–47 could not land on a grass field with a belly tank still attached. Roger A Freeman, *Mighty Eighth War Manual* (London: Jane's Publishing Company Limited, 1984), p. 190, [Hereafter Freeman, *Manual*].

24. Freeman, *Manual* pp. 190-191

25. Murray, *Defeat,* shows a combat radius of 375 miles for the P–47, (130) but that is exaggerated; actual combat radius was closer to 325 miles. See VIII Fighter Command, "Achtung Indianer," July 24, 1944, File 168.6005-54, Plate xii, Air Force Historical Research Agency, Maxwell AFB, Ala., quoted in McFarland, p. 105.

26. McFarland, pp. 120, passim;

27. Francis H. Dean, *America's Hundred Thousand: U.S. Production Fighters of World War II,* (Atglen, Pa.: Shaffer Publishing, 2000), p. 284, [Hereafter Dean].

28. One pilot said "those monstrosities" slowed the P–47 by 50 mph, Dean, p. 308; other less emotional sources say 15-20 mph. In early 1945, the VIII AF Service Command developed a flat bottomed 215 gallon tank that allowed the wing pylons to be removed, Freeman, p. 221

29. This was shown in the Battle of Britain, notwithstanding Adolf Galland's comments. See Stephen Bungay, *The Most Dangerous Enemy: A History of the Battle of Britain,* (London: Aurum Press, 2000), pp. 304, *passim*.

30. Jerry Scutts, *Lions in the Sky: U.S. 8th Air Force Operations Fighter Operations 1942-1945,* (Wellingbrough, Northamptonshire, UK: Patrick Stephens, 1987), p. 12.

31. Jerry Scutts, *Bf 109 Aces of North Africa and the Mediterranean*. (Oxford, UK: Osprey Publishing, 1994), p. 61.

32. Bernard L. Boylan, *The Development of the American Long-Range Escort Fighter.* Unpublished Ph.D. dissertation, University of Missouri, 1955, p. 135, [Hereafter Boylan]; McFarland, p. 105.

33. For Hap Arnold's comments before he sent the P–38s to England, see "Case History of Fighter Range Extension Program, Parts 1 and II," USAF Historical Research Agency Document 202.2-11, Feb. 22, 1945.

34. *Kings Cliffe Memorial Edition,* (History of the 20th Fighter Group) 1945, republished in 2004 by Sheridan Press, p. 112, [Hereafter *Kings Cliffe*].

35. These problems are widely discussed. See, for example Freeman, pp. 90-91, and 184-86.

36. Dean, p. 165.

37. Dean *pp.* 164-66.

38. Philip Kaplan and Andy Sanders, *Little Friends: The Fighter Pilot Experience in World War II England* (New York Random House, 1991), p. 62, [Hereafter Kaplan].

39. Craven and Cate, Vol. III, p. 11; Freeman, p. 185.

40. Kaplan, p. 63.

41. Kaplan, p. 62.

42. Dean, p. 158.

43. Dean, p. 160. For a the impressions of a P–38 pilot who liked the aircraft, see Kaplan, pp. 56-62.

44. *Kings Cliffe, p.* 113.

45. For the P–38 pilot's remarks, see Price, *Fighter Conflict,* (London Macdonald and Jane's, 1975), pp. 148-50. For Galland's comments, see McFarland, p. 56.

46. Boylan, p. 175.

47. Craven and Cate, Vol. III, pp. 35, 43.

48. Mark Wells, *Courage in Air Warfare: The Allied Experience in the Second World War* (Frank Cass, London, 1980), pp. 103-104, *passim.*

49. Craven and Cate, *Volume III.* 9, 30-31.

50. The program began in late 1943, but the first group to be fitted, the 56th FG was not completed until April. See Freeman, p. 190.

51. Freeman, pp. 185-86.

52. http://www.lanpartyworld.com/ww2/alliedair.htm Interview with Col. Francis "Gabby" Gabreski from General Dynamics *Code One* magazine, date unknown.

53. The importance of these attacks is well documented. An excellent source for a description of the oil campaign is Ronald C Cooke and Roy C. Nesbit, *Target: Hitler's Oil: Allied Attacks on German Oil Supplies 1939-1945*, (London: William Kember, 1985), for a briefer description, see Murray, pp. 201-7, *passim*.

54. No great feat—the P–40 was a poor performer.

55. William Green, *Famous Fighters of the Second World War Volume One*, (London: Hanover House, 1957), p. 92.

56. Air War College Lecture by General Orville Anderson, "Development of U.S. Strategic Air Doctrine, ETO, World War II," Sep. 20, 1951, USAF HD239.7162-6.

57. Boylan, p. 151.

58. Boylan, pp. 150-51.

59. Paul A Ludwig, *The Development of the P–51Mustang Long-Range Escort Fighter.* (Surrey, UK: Classic Publications, 2003), pp. 61-68, [Hereafter Ludwig].

60. Well documented; see Ludwig, pp. 131-32.

61. In fact, there was such a proposal, but it never came to fruition. The closest was the P–38K, with new Allison engines and paddle bladed propellers; it seems to have had spectacular performance, but the AAF was unwilling to stop production for a few months to make the changes.

62. Ludwig, pp. 153-55, passim.

63. The story of the slow development of external fuel tanks for American fighters is a long and distressing one. See *Development*, pp. 121-34, passim; for a more concise version, see Ludwig, pp. 168-70.

64. Ludwig, pp. 164-65.

65. Price, *Fighter Conflict,* pp. 111-16.

66. Derived from Kent D. Miller, *Fighter Units & Pilots of the 8th Air Force September 1942 - May 1945: Volume 1 Day-to-Day Operations - Fighter Group Histories.* (Atglen, Pa.: Schiffer Publishing, 2000). These are claims, not confirmed by German records, but they provide an order of magnitude.

67. Garry Fry and Jeffery Ethell, *Escort to Berlin: The 4th Fighter Group in World War II* (Arco Publishing, New York, 1980), pp. 131-51; also "Fourth Fighter Group Victories," Official Website of the 4th Fighter Group," http://www.fourthfightergroucom/resource/victories.html

68. Caldwell, p. 175.

The Day of Battle: The War in Sicily and Italy, 1943-1944. [Volume 2: The Liberation Trilogy] By Rick Atkinson. New York: Henry Holt and Co., 2007. Maps. Photographs. Notes. Bibliography. Index Pp. xvii, 791. $35.00 ISBN: 0-8050-6289-2

The rationale and justification for the Italian Campaign is uncertain and controversial. It obviously didn't have the high priority of a second front in Northern Europe or even the war in the Pacific—at least in American eyes. Those of us who fought and bled there like to think it served some purpose, but this second installment of Atkinson's trilogy on the war in Italy leaves some doubt about that.

The book is entertaining and moves at a fast pace despite its length. The lively read does have some shortcuts in accuracy. With a plethora of details and anecdotes, some errors inevitably crept in, but they're only a minor irritation. However, it's a raw rookie's mistake to say "Congressional" Medal of Honor. "Shrapnel" is often misused, as well, but only a true Red Leg would get excited about this.

To give a personal touch to the history, Atkinson frequently used letters to home and individual diaries (the latter, of course, written in violation of regulations more often followed by lower ranks). Both of these have to be treated with caution as they were often written with an eye for posterity or CYA (cover your ass). The author is objective in relating the bad with the good—panic, friendly fire, and faults of leadership such as arrogance and misplaced ambition.

The style of the notes is inconvenient except for ardent researchers. The sources are numerous (30 pages worth) and recent, but it's not clear how many bring fresh insight. Together, however, they've been tapped to form a fascinating mosaic, especially if the reader is interested in George Marshall's compost pile or Alan Brooke's bird watching. Some of this background is more than entertaining. It helps readers visualize the dimensions of key players. The account is enlivened by historic references. As should be hoped for in a book of this length, there are some good photographs that help to understand the story. The maps are adequate, but not all of the places mentioned in the text are easily found. The two chains of command presented are useful but leave a gap for the period between.

I was there during the time covered by this book and have read most significant (and some not so significant) histories about this period of the Italian campaign. I found the book to be a useful addition to the knowledge of this facet of World War II. I appreciated Atkinson's first volume as well and look forward to the last.

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The Day of Battle: The War in Sicily and Italy, 1943-1944. [Volume 2: The Liberation Trilogy] By Rick Atkinson. New York: Henry Holt and Co., 2007. Maps. Photographs. Notes. Bibliography. Index Pp. xvii, 791. $35.00 ISBN: 0-8050-6289-2

The Day of Battle is the sequel to Atkinson's Pulitzer Prize-winning *An Army at Dawn* (2002). Unlike many sequels, it represents a considerable improvement over the excellent first installment of the "Liberation Trilogy."

Atkinson picks up the story of the American Army in World War II Europe where he left it at the end of *An Army at Dawn*: North Africa is in Allied hands, and President Franklin Roosevelt and Prime Minister Winston Churchill must decide what to do next. Allied military and political strategists concluded—reluctantly on the part of most Americans—that the time was not yet right for a cross-Channel invasion and that Allied troops could not wait a year before reengaging Axis forces. Therefore, a campaign to knock Italy out of the war by conquering Sicily and the Italian peninsula developed. Many hoped the Italians would fold quickly, prompting a German retreat to the Alps. While the Italian surrender did come quickly, it led instead to the German occupation of Italy and a long, bloody, exhausting campaign to force the Germans north valley by valley, hill by hill, until the capture of Rome, where Atkinson ends this volume.

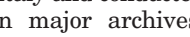
Atkinson is an engaging writer with a flair for description. That readable style rests on a foundation of exceptionally broad research. He studied the important English-language scholarly and popular histories of the war in Italy and conducted research in seventeen major archives. While the publisher unfortunately chose the bizarre page-paragraph method of citing sources, rather than more traditional and useable footnotes or endnotes, the book is well documented.

Between the covers, readers will find the big names (Eisenhower, Patton, Alexander, Clark), the well-known (Audie Murphy, Bill Mauldin, Ernie Pyle), and the big battles and incidents (the Patton "slapping incident," the race to Messina, Salerno, Monte Cassino, Anzio, and the controversial Fifth Army turn toward Rome). Atkinson deftly balances these with less-well-known but critical people, incidents, and experiences: VAdm Henry Hewitt, rampant venereal disease, Lt. Col. Jack Toffee, and self-inflicted wounds. All are well illustrated with quotations from letters, diaries, newspapers, and official reports. He is unafraid to make judgments of commanders, decisions, and soldiers' conduct, but these are considered and carefully take into account who knew what and when. Atkinson is no Monday-morning quarterback.

The Day of Battle, despite its inclusive subtitle, continues *An Army at Dawn*'s emphasis on the growth and development of the U.S. Army. Allied and enemy forces, and the civilians trapped between them, receive enough coverage to ensure readers understand the context of what American soldiers experienced. The navies receive solid treatment during the amphibious operations but fade from sight after the landings. Atkinson has somewhat expanded and improved his coverage of logistics and the men in the support branches from his first volume, though his focus clearly remains on combat.

Readers of *Air Power History* will be especially interested in Atkinson's coverage of air matters. He seems to have adopted the infantryman's long-standing belief that if an airplane is not in sight doing exactly what the infantryman wants, it cannot really be doing anything useful. Air power makes its presence felt in the narrative in paratrooper operations, pre-invasion bombardments, and close air support. Interdiction and strategic operations receive mention, but are clearly peripheral to the main story. Moreover, coverage of air power failures—especially errant attacks on friendly troops—almost seems to outweigh the coverage given to air power successes. Nevertheless, unless the reader's interest is exclusively in air operations, *The Day of Battle* is an excellent study and is highly recommended.

Maj. Grant T. Weller, USAF, Ph.D., Department of History, U.S. Air Force Academy



Gunning for the Red Baron. By Leon Bennett. [C.A. Brannen Series: Number Seven] College Station: Texas A & M Press, 2006. Illustrations. Photographs. Glossary. Notes. Bibliography. Index. Pp. 207. $29.95. ISBN: 1-58544-507-X

This book has received relatively mixed reviews in various magazines and journals. While it is difficult to disagree with most of the reservations encountered, particularly regarding the neglect of some sources and the occasional and slightly

confusing lack of focus (especially near the end of the book when the author ventures into such hypothetical questions as to how many victories might have been possible for a First World War fighter pilot to attain), none of this greatly diminishes my admiration for *Gunning for the Red Baron*.

Bennett is an aeronautical engineer who drew on his army experience working in the Ballistics Research Laboratory, library and archival research, and the expertise of his physicist brother, Stewart. The result is an absolutely fascinating book that offers an original look at air combat during World War I. By simply acknowledging at the outset that conversations with Stewart, an expert on optics, gave him the confidence to make "so sweeping a rationale for tracer disappointments," Bennett offers the discerning reader an early hint that his is a different take on our first great air war.

He sets out a clear interest in his introduction: "the craft of shooting down airplanes in the Great War." He then takes us through a detailed consideration of weapons, gunsights, ballistics, optical illusions, and human factors involved in identifying the successful fighter pilot of that pioneering era of air power. He demonstrates quite conclusively that shooting down one of those flimsy early flying machines was not nearly as easy as many of us laymen may naively assume.

Bennett does this by thematically investigating and explaining various aspects of the problem and attempted solutions and then illustrating and amplifying his conclusions with occasional examples of incidents familiar to aficionados of the first air war. And herein lies one of the little problems that might upset some readers—especially if they picked up the book expecting to read the last word on the contentious subject of the final flight of the "Red Baron," Manfred von Richthofen. To some degree the title is more metaphorical than literal. Yes, Bennett analyzes the demise of the feared and admired German ace; however, he does so in one imaginative chapter bearing the same title as the book and only after systematically leading the reader through seven preparatory and quite technical chapters discussing engineering advances on both sides as the air forces and their leaders leapfrogged one another in a desperate search for aerial supremacy. Throughout this process he uses photos, diagrams, charts, and graphs to clarify—and, it must be admitted, occasionally to confuse—things for the lay reader.

The chapter on the end of the Red Baron includes an analysis of the aerial duel between the German ace and the Royal Flying Corps' Major Lanoe Hawker, on November 23, 1916, before zeroing in on the famous April 21, 1918 engagement that gave the Royal Air Force an opportunity to claim credit for eliminating this already iconic enemy threat. Interestingly (especially for a Canadian reviewer), while the official history of the Royal Canadian Air Force suggested in a footnote almost thirty years ago that, "It is now difficult to argue that [the Canadian pilot] Roy Brown killed Richthofen," Bennett—after fairly careful consideration—can only conclude: "Either Brown or the unknown rifleman appear more probable as victors." For his rejection of the claims of ground-based machine-gunners (given credit by many investigators of the file, including Norman Franks and Alan Bennett in *The Red Baron's Last Flight* and, most recently, Frank McGuire in *The Many Deaths of the Red Baron: The Richthofen Controversy, 1918-2000*), you should read the book. You will be glad you did.

Anyone with any interest in air warfare would undoubtedly enjoy *Gunning for the Red Baron*. Many will undoubtedly want to read it again. I expect to dip into it quite regularly for clarification of early air combat problems.

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Clash of Eagles: USAAF 8th Air Force Bombers Versus the Luftwaffe in World War 2. By Martin W. Bowman. Barnsley, South Yorkshire UK: Pen and Sword Aviation, 2006. Photographs. Glossary. Index. Pp. xi, 254. $50.00 ISBN: 1-84415-413-0

Clash of Eagles is the story of the men from both sides who fought and died in the air over Germany and occupied Europe during the Second World War. Making extensive use of the personal recollections of the participants involved, Bowman does an exceptional job of placing the reader at the scene, whether it's in the fuselage of a bomber at 20,000 feet, or back at base in the crew's Nissen hut waiting for the next mission.

The major American bombing missions are presented in chronological order in a level of detail not normally seen. Wherever possible, the losses are indentified by aircraft name, and the fates of individual crew members are recounted. At the same time, the identities of their adversaries and their stories are told putting the entire battle into context. It is very much like reading the sports page and reliving the previous day's big match play by play, though the reader is constantly reminded of the deadly serious nature of that great aerial contest.

Most surprising is the behavior of the bomber crews own fellow airmen. All too often a crew returning late from a mission and presumed lost arrived back to their home station to find their personal belongings had been looted by their squadron mates. This practice was apparently widespread due, in no small part, to the shortages of virtually everything as a result of the war. War brings out the worst in everyone, it seems.

As an oral history, there is an abundance of information which, thankfully, has now been preserved. The views of the opponents are expertly woven together to present an integrated, flowing narrative. Notably absent is the perspective of the escort fighter pilots who after 1943 were an indispensible part of the equation and a major component of the Eighth Air Force. Their activities and whereabouts at any given time weighed heavily on the minds of friend and foe alike, and their often decisive contributions warrant their inclusion in any discussion of the battle waged in the air.

Ultimately this book is about personal combat experiences and not about strategy or even tactics. For the most part, the participants' words speak for themselves and commentary by the author is limited. In some cases, more commentary would have been beneficial to novice readers to help clarify why certain weapons were used or why the Americans persisted in their costly daylight raids. The book ends as suddenly as the war and there is no sense of victory or defeat—only survival.

Maj. Anthony E. Wessel, USAF (Ret.), Oklahoma City, Oklahoma

Red Moon Rising: Sputnik and the Hidden Rivalries That Ignited the Space Race. By Matthew Brzezinski. New York: Times Books: Henry Holt and Co., 2007. Photographs. Notes. Index. Pp. 323. $26.00 ISBN: 0-8050-8147-3

On the fiftieth anniversary of the 1957 Sputnik launch, Matthew Bzrezinski examines the early Soviet and American space programs, beginning with their race to capture German scientists and rocket systems in the closing days of World War II. He notes that while the USSR eventually controlled most of the V-2 assembly sites, especially the Mittelwerk compound near Nordhausen, the Americans had captured,

in accordance with General Eisenhower's orders, over 100 intact rockets and most of the leading 100 German scientists, led by Dr. Wernher von Braun. Those missiles and their German masters spent the next five years in miserable isolation near Ft. Bliss, Texas, before the U.S. began its own serious research at the Redstone Arsenal.

The prevailing opinion of the Eisenhower administration was that the bomber would control the world's destiny. Gen. Curtis Lemay's Strategic Air Command and its Boeing bombers dominated defense strategy and budgets, although with a considerable level of support from Democratic hawks. The USSR, recognizing its insurmountable deficit in economic and industrial strength, and fearful that SAC could actually attack its inferior forces with impunity, considered the ICBM as the weapon to leapfrog American technology and industry. The Pentagon only reluctantly funded U.S. missile research and tacitly encouraged competition between the Army, Navy and Air Force for control of that technology. American scientific efforts were concentrated in the Navy's immature and flawed Vanguard program (American scientific efforts were surrogates for military R&D, as were the Soviet Union's "peaceful" trials). As a result, Soviet progress, though far from steady, enabled their chief designer Sergei Korolev (the book's most positive portrayal), himself a survivor of pre-war Stalinist purges, to offer Premier Nikita Khrushchev the opportunity to use the massive, but militarily useless, R-7 rocket to launch man's first orbiting satellite.

This happened against a background of confusion and uncertainty in the USSR. Khrushchev's 1956 "secret speech" repudiated the legacy of Joseph Stalin's reign but did not bring Khrushchev any real degree of power (he withstood a 1957 purge attempt with the help of legendary soldier Marshal Georgi Zhukov, who had supportive Central Committee members flown to Moscow in Red Air Force bombers for a key showdown). Sputnik established the USSR as the more powerful superpower in the view of many non-aligned nations. Its aftermath defined U.S. political discourse for the last three years of the Eisenhower administration and facilitated Lyndon Johnson's entry onto the national political stage. Sputnik drove the US military "roles and missions" debate, and led to the decision to strip the Army of its role in the IRBM and ICBM programs (ironically, the Army had the nation's best structured and most advanced space R&D effort, led by the book's second strong character, Gen John B. Medaris). It led to establishment of NASA and the 1958 National Defense Education Act, and almost directly to the 1960 shootdown of an American U-2 over the USSR and the ensuing Cuban missile crisis. Ironically, the latter so weakened Khrushchev that he was in fact deposed in 1964.

This is a readable, even humorous, book written by a skilled veteran reporter. Its subject, while compelling in its own right, is used to examine the American political (and cultural) scene and to show how society and technology changed dramatically as the backward Soviet Union scored its biggest political victory of the Cold War by launching a 184-pound object into space.

Lt. Col. J. Ron Davis, USAF (Ret.), Docent, National Air and Space Museum

Danger Close: Tactical Air Controllers in Afghanistan and Iraq. By Steve Call. College Station: Texas A&M University Press, 2007. Maps. Photographs. Appendix. Glossary. Index. Pp. xvii, 250. $29.95 ISBN: 1-58544-624-7

Steve Call now works as an assistant professor of history at Broome Community College in New York; his military resume uniquely equips him to write this book. Before retiring from the Air Force, Call served as a liaison officer to the US Army and a squadron commander. As a liaison officer, Call gained the insight and experience necessary to understand the relationships and roles of the subject matter, namely Air Force Tactical Air Control Parties (TACP).

Danger Close chronicles the roles of air controllers in the early parts of both the Afghanistan (Operation ENDURING FREEDOM) and Iraq (Operation IRAQI FREEDOM) campaigns, the subordinate operations in the larger Global War on Terror (GWOT). The overall approach of the book is descriptive. Starting with a very brief overview of the history of air controllers, Call launches right into action in Afghanistan by discussing the roles of close air support (CAS) in the conflict. The second part is much the same but from the perspective of Iraq. Call comments about the future of tactical air control and close air support, but his goal is not to convince or theorize. It is primarily to inform the reader about TACP innovations and contributions to the greater combat effort.

The strongest feature of the book is Call's extensive use of interviews. He amassed a large number of in-depth interviews with key personnel at the tactical, operational, and strategic levels and seamlessly wove these eyewitness accounts into his narrative. The result is effective for two reasons: first, it intersperses primary source descriptions into the overall narrative flow of this work and, second, it gives the book a very readable rhythm.

This book will fit well into the body of literature that is sure to emerge from the so-called Long War. Books and articles have already appeared chronicling these events, but volumes will no doubt appear—especially the official versions produced by the various uniformed services. What is special about this book is its ability to bridge the gap between services. Though TACPs are composed of Air Force personnel, they most often work in Army units. These interservice jobs can easily be overlooked as "out of sight, out of mind."

Overall, this book boasts both high readability and utility. Perhaps not as well documented as it could have been (the author included very few notes), the book's strength derives from Call's experience, insight, and the large number of interviews he used.

David J. Schepp, Seventh Air Force Historian, Osan Air Base, Republic of Korea

A Tale of Two Quagmires: Iraq, Vietnam, and the Hard Lessons of War. By Kenneth J. Campbell. Boulder, Colo.: Paradigm Publishers, 2007. Photographs. Index. Pp. 134. $18.95 Paperback ISBN-13: 1-59451-352-7.

The Iraq and Vietnam wars remain two highly controversial conflicts that have had a major impact on the U.S. military; on political relationships of the United States within the international community; on the American people; on the current war on terrorism; and not on the two war-torn countries. Having said that, are these two wars alike?

Dr. Campbell opens chapter one, "The Great Debate," with the central question: "Is Iraq another Vietnam?" He does not immediately state his position. First, he addresses the views of other scholars who believe that Iraq is not Vietnam. He then follows with those who say that Iraq is Vietnam. Retired Army Lt. Gen. William Odom, sourced in this book, said, " that of the many similarities between the wars in Iraq and Vietnam, the most important were the use of 'phony intelligence' and 'confused war aims.'" After introducing the various view points, Campbell states, "that on the most important level—the strategic political level—Iraq and Vietnam are exactly alike." "As such they were and are quagmires." Campbell defines this popular politico-military metaphor as a "military intervention that seems so easy to enter, but so difficult to exit." He goes on to high-

light deception, at the highest levels of government, as the key ingredient in a quagmire's sticky mix. Then the author enters into an interesting digression; he spends the next twenty pages revisiting his service as a young marine in Vietnam and the impact that war has had on his views. He allows the reader to appreciate the genesis of his thoughts on war. His two decades as a scholar have, of course, further shaped Campbell's approach to this book's thesis.

I have known Ken Campbell for a number of years and have discussed with him the Vietnam War and, more recently, Iraq. He served, just as I did, in Vietnam in 1968 during the most intense ground combat of the war. Campbell went on to become an academician; and I went on, after a half dozen more conflicts and contingencies, to serve in Iraq in the current war. Consequently, my interest in reading this book is to broaden my understanding of these two conflicts both professionally and on a personal level. I sense that many Americans in general have been comparing the two wars and will be interested in Campbell's perspective. Importantly, in publishing this timely work, he has succinctly captured important and insightful lessons of both wars from his own perspective and from scholars across the spectrum of political thought. He also addresses in more general terms the connectivity between faulty decision making and war making.

Campbell is very critical of the respective decisions to go to war in Vietnam and Iraq. While the reader may not concur with his take on the two wars, he does capture the viewpoint held by a substantial body of scholars and ordinary Americans. For these reasons, I believe a reader will appreciate the value found in contrasting these two very important wars.

Col. John L. Cirafici, USAF (Ret.), Milford, Delaware

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Risk and Exploration: Earth, Sea and the Stars [NASA Administrator's Symposium, September 26-29, 2004, Naval Postgraduate School, Monterey, Calif., NASA SP 2005-4701]. By Steven J. Dick and Keith L. Cowing, eds. Washington DC: NASA History Division, 2005. Illustrations. Photographs. Index. Pp. ix, 294. $44.00 (available for free in PDF format at http://history.nasa.gov/SP-4701/riskandexploration.pdf) ISBN: 0-16-074974-3

When accidents happen in highly visible realms of exploration or technology development, the question of balancing risk and benefit emerges. In the aftermath of the 2003 *Columbia* disaster, then-NASA Administrator Sean O'Keefe struggled with this issue while seeking to ensure an appropriate cultural balance between risk and benefit within NASA. O'Keefe and his colleagues saw the problem not only as whether NASA accepted too high a level of operational risk with the Shuttle system but whether "the exploration of space is worth the risk of human life." For an organization whose mission includes advancing human exploration of space and developing advanced aeronautics and space technologies, he fundamentally questioned NASA's *raison d'être*.

Readers of *Air Power History* will realize that this work is a primary source reflecting NASA's state of mind post-*Columbia.* It is not a history work per se. This volume presents the proceedings of a 2004 conference in which selected invitees addressed whether the cause of space exploration is worth risking human life. Specifically, it discusses risk and its mitigation. The speakers were wonderfully broad, describing how exploration and expeditions in several realms, including land, sea, and space, manage risk to achieve objectives. Astronauts figure prominently, as do mountaineers, spelunkers, deep-sea explorers, and those responsible for the robotic exploration of other planets.

The attractively illustrated and bound volume has four parts, one each for earth (mountaineering and spelunking), sea (deep oceanic research, exploring shipwrecks, and ocean futures), space (human and robotic exploration), and a final section entitled "Why We Explore." The contributors range from noted Apollo- and Shuttle-era astronauts and scientists to writers, astrobiologists, and experts in these various realms, including undersea explorer John Chatterton of History Channel fame, filmmaker James Cameron, and Jean-Michel Cousteau, who continues his father's pioneering work. Despite their disparate fields, there emerged several points of convergence; the questions-and-answers following each portion illuminate these.

The proceedings illustrate the importance of planning and applying lessons learned to expeditions into the unknown. Moreover, important to each explorative domain was identifying and balancing different types of risk, including personal, programmatic, technical, survival of the species, and the risk of not exploring against its potential gain. Here the participants often drew a distinction between performing a long-term expedition and a short-term trial such as a test flight or experiment. To these individuals, the former requires a deeper commitment and understanding of risk. They do not disparage the latter but, rather, emphasize the importance of a mindset recognizing the stresses involved in conducting long-term exploration in which a quick return to home base cannot mitigate significant psychological and physical stresses. Because of the uncertainty of such efforts, estimating risk is maddingly difficult. As Jack Stuster, Vice President of Anacapa Sciences, Inc., notes, humans "have a tendency to underestimate risk over which we have some control, and to overrate risk over which we have no control."

O'Keefe asked these manifold experts to discuss their personal views to frame NASA discussion, debate, and evaluation of risk. What emerged was a feeling that all explorers, despite differences in terminology, more or less evaluate risk similarly, although specific modeling differences exist. Perhaps not surprising, nearly all of the participants believe that human space exploration must proceed forward, that it is a genetic if not spiritual imperative of species survival. Readers of aerospace literature will recognize these familiar arguments. A stronger and more numerous set of counterarguments would have balanced better the proceedings; however, the conference's primary objective was to discuss and understand risk to help NASA's spaceflight mission. In this sense, the proceedings discuss expeditionary risk from a variety of perspectives. Those interested in contemporary human space exploration or organizational approaches to risk management may want to review these proceedings.

Lt. Col. Steven Pomeroy, USAF

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Under the Guns of the Red Baron: The Complete Record of Von Richthofen's Victories and Victims Fully illustrated: By Norman Franks, Hal Giblin, and Nigel McCrery. London: Grub Street, 2007 [2d ed.]. Maps. Diagrams. Notes. Illustrations. Photographs. Glossary. Bibliography. Index. Pp. 224. £12.99 Paperback ISBN: 1-904943-97-7

Many books have been written about fighter aircraft in World War I. Norman Franks, the principal author of this book, has, himself, published thirteen. Baron *Rittmeister* Manfred von Richtoven, who became known as the "Red Baron," was the "Great War's" leading ace. This book's main aim is to "put flesh on the bones to the identities of the many young men who comprise the cold statistics" of Richthofen's victims. It does not attempt to discuss in detail the personality, tactics, or lasting contribution of the Red Baron to fighter aircraft culture and the contribution of that type of aircraft to the art of war. This is a small loss as so much as already been published on these subjects.

The book is arranged chronologically by von Richthofen's eighty confirmed kills. In each of these sections there is a narrative by the authors on what is known from available allied and German sources about the engagement. These narratives are bookended by von Richthofen's combat report and biographies of the allied victim(s). A victory frequently had two victims, always British or British subjects who, with few exceptions, were very young (the Red Baron himself was only twenty-six when he was killed). They were generally inexperienced in combat as a pilot or observer. All were volunteers. Many came from distant points of the Commonwealth to fight for "King and Empire." There were many Canadians, Australians, and New Zealanders and a few from Austria, Argentina, and Russia. The most prevalent method of qualifying for a cockpit assignment was to start in the trenches as a soldier. Many British aviators had been promoted and decorated for ground service prior to volunteering for, and being accepted into, observer or pilot training. In fact, it was almost the rule that the path to the air service, particularly as an observer, led through the trenches.

Although some victims of the Red Baron had as little as forty-five hours of flying time (one was on his first combat sortie), several were of proven competency. Major Lanoe Hawker scored his eleventh victory and was Britain's first ace. His loss was a blow to home-front morale. Victory number fifteen was Sergeant James McCudden, who started his military service as a bugler. He survived his shootdown by the Red Baron and went on to be credited with fifty-four German kills before he died in an aircraft accident on July 9, 1918, shortly after the *Rittmeister*'s controversial death and four months before the armistice.

A thumbnail analysis shows that seventy-six airmen were killed by Von Richtofen and eighteen became prisoners of war. Twenty six of the kills were two-seat aircraft. Therefore, many crew members actually survived. The number of German kills credited to the victims of the Red Baron's guns was 114-1/2. About 90 percent of the kills credited to this group were made by a tenth of the men, and more than half were made by Sgt McCudden. Frequently, victims either did not see him or were in a low-fuel mode fleeing to their own lines and could not afford to maneuver. This is no surprise to anyone familiar with fighter warfare. Additionally, Von Richthofen's predilection for firing at extremely short ranges and his obvious contempt for those who did not, is well known. For these reasons contemporary academics sometimes refer to the *Rittmeister* pejoratively as an "assassin." There is little doubt that he would not have felt hurt by this appellation. After all, if one is engaged in a fair fight, your planning is bad.

Should a reader desire to study the history of the aerial fighter in war, this volume, along with Peter Kilduff's *Red Baron, The life and Death of an Ace*, is a good place to start. As historiography, the authors have worked diligently to sort out conflicting stories to arrive at the most plausible narrative. The biographies provide good backgrounds of the times and culture of the period, and they succeeded in putting human faces on the bloody events.

Col. Jerry Hoblit, USAF (Ret.), Willis, Texas

Band of Sisters: American Women at War in Iraq. By Kirsten Holmstedt. Mechanicsburg Pa.: Stackpole Books, 2007. Photographs. Index. Pp. xxiii, 327. $27.95 ISBN: 0-8117-0267-6

Kirsten Holmstedt wrote *Band of Sisters* as "an attempt to take a close look at how the experimentation of women in combat is playing out." She says that more than 40,000 women were sent overseas during the 1990 Gulf War—a dramatic increase from the 10,000 women (mostly nurses) who served in the Vietnam War. In 1993, Secretary of Defense Aspin ordered all combat aviation open to women; one year later other combat support jobs began accepting women into their ranks. As a result, according to Holmstedt, more than 90 percent of U.S. Armed Forces career fields will now be filled by simply the best qualified person.

Stating she was "too old to enlist" after the events of September 11th, Holmstedt became engrossed with the "military actions" unfolding first in Afghanistan and then in Iraq. Living near the military communities of Camp Lejune and Pope AFB in North Carolina also fueled her desire to get to know the women who had served in Iraq. She wanted to know their "mind set," their motivation to join the military and, most importantly, their war experiences in their own words. In her book she uses both words and photographs to capture the experiences of these women as they lose friends, lose limbs, and recover both emotionally and physically after their return from war.

Band of Sisters captures in their own words the experiences of eleven women who served in Iraq. The best part of this book is that the veterans do speak in their own words, describing what an IED under their vehicle feels likes, smells like, sounds like, and even what the explosion does to their teammate's body, lying dead beside them in the passenger seat. One annoying distraction is when Holmstedt offers her own thoughts on what the combatant was feeling at the time, trying to explain their situation or thought process. Often, she interjects with a short sentence that is written at a 6th-grade level, explaining that when helicopters are shot down, they often "fall." These somewhat juvenile inputs detract from the powerful images that are best described when the veterans share their own stories without the author interrupting.

There are eleven chapters, one for each interviewee: five Marines, three soldiers, two sailors, and just one airman. Four of the women are in aviation: two Marine pilots (F–18 and Cobra), one Army Kiowa helicopter pilot, and an Air Force C–130 pilot.

Examples include a chapter titled "School House Rocks," where two female Marines serving in combat service support roles describe their experiences in a Haditha schoolhouse where both witnessed the loss of life and also took lives. The women—both in their twenties—describe daily life in Iraq, the challenges of being accepted by men, their fears of failing in front of them, and their emotions after killing insurgents.

An Army Kiowa helicopter pilot relives her helicopter being shot down near Fallujah. After surviving the crash, she and her co-pilot escape and evade until rescue. Her chapter also goes into her personal life with her husband, another helicopter pilot, and her father, a former chief of operations at West Point.

Not the best chapter, but perhaps the best title, comes from a Marine captain, the first African-American female pilot in USMC history and the first black female combat pilot in U.S. history. In "Who Wants To Be Average?" she details her strengths and weaknesses as she flies and fires missiles, guns, and rockets from her Super Cobra in close air support of Marines on the ground.

Perhaps that title sums up the common theme among all these stories. None of these ladies, from the 18-year-old, .50-caliber gunner running troop convoys to the 41-year-old C–130 commander (and wife plus mother of three) wanted to be "ordinary." They enlisted or received commissions for a variety of reasons. They served, and some would later separate, with a mixed bag of reasons and emotions. This book is most appealing to women in uniform, especially those who have served in combat. Regardless of who picks up this book, however, it should be read without the stigma of a pro-feminism slant, but rather with admiration of what these eleven women went through and accom-

plished. More than 155,000 women have deployed to Iraq and Afghanistan since March of 2003. These are the stories of eleven of them.

Maj. Laura E. Johnson, Instructor, Department of History, USAF Academy

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The Development of Propulsion Technology for U.S. Space-Launch Vehicles, 1926-1991. By J. D. Hunley. College Station: Texas A&M University Press, 2007. Illustrations. Photographs. Notes. Bibliography. Index. Pp. xi, 383. $65.00 ISBN: 1-58544-588-6

A skillful synthesis of material from an enormous number of books and periodicals, amply buttressed with primary documentation extracted from different archival repositories and other sources, ensures J. D. Hunley's volume a prominent place on every serious space historian's bookshelf. His understanding of the complex technologies associated with access to space, coupled with his ability to explain it in an engaging narrative format, makes this book informative to a diverse audience. Whether highly educated in the sciences, broadly experienced in engineering, or simply intrigued by the challenges—physical, chemical, managerial, organizational, and otherwise—of rocketing into space, readers will glean refreshing insights to the several lines along which propulsion technology for space-launch vehicles evolved.

Hunley tells the story in eight chapters. As he explains in the preface, this book is essentially an extraction from a much longer manuscript covering the "entire gamut" of major space-launch vehicle technologies. Consequently, the book's first two chapters supply the broader context of space-launch technology development for the next five chapters on the history of different lines of propulsion technology: alcohol and kerosene fuels, storable fuels and oxidizers, liquid hydrogen and oxygen, and solid propellants. The brief eighth chapter offers a reflective commentary on how lessons drawn from the period from Robert Goddard's launch of the world's first liquid-propellant rocket in 1926 to the end of the Cold War in 1991 might inform participants in a new era of propulsion development. Presumably, the remainder of Hunley's longer manuscript appears in two subsequent volumes—*Preludes to U.S. Space-Launch Vehicle Technology: Goddard Rockets to Minuteman III* and *U.S. Space-Launch Vehicle Technology: Viking to Space Shuttle*—published by University Press of Florida in 2008.

He offers several thought-provoking observations or conclusions based on historical examples. These begin with a characterization of engineering as more art than science, because engineers focus on what works even when nobody can explain why it works. Even as rocket-engine development processes evolved from empirical, test-and-fail methods in the 1950s and 1960s to more analytical, computerized mathematical-modeling methods by the 1980s, engineering remained more art than science. In addition, he differentiates between technical and heterogeneous engineering skills, the latter pertaining to social as well as technical aspects of project management. While not denying the phenomenon of a single individual having an inventive "eureka moment," he concludes the synergistic effects of people sharing information through teamwork contributed far more to breakthroughs in propulsion technologies. Finally, he takes exception to the existing literature's emphasis on competition and inter-service rivalries, finding instead commendable amounts of cooperation among the military services and other organizations that shared information and transferred technology.

Having spent a quarter-century working on aerospace technology in USAF and NASA history programs, Hunley obviously knew which people to contact and where to research for comprehensive coverage of his subject. Even in the best treatises, however, one usually finds minor flaws. This book is no exception. In his discussion of the revolutionary transition from Titan I to Titan II, Hunley fails to mention the crucial influence of program manager Colonel Albert J. "Red" Wetzel. Later, he refers to Bell as manufacturer of the Agena B space vehicle, when the actual builder was Lockheed using a Bell engine. While confessing near the end of his narrative that it often is hard in rocketry literature to pinpoint who introduced specific innovations, his attribution of the Thor tank's waffle-like structural design to Douglas Aircraft differs from what I learned from one member of the Air Force's Thor development team, who credited Navy Captain Robert C. Truax. Rather than detract from the outstanding quality of Hunley's work, however, these things merely strengthen his statements about the convoluted complexity of the story.

This might not be the "definitive study" claimed on its dust jacket, but nobody should doubt that it is comprehensive scholarship. Anyone aspiring to address this subject in the future must be prepared to reckon with Hunley's professional shadow. Unquestionably, his companion volumes on other aspects of U.S. space-launch vehicle technology will join this one to form a daunting historical trilogy.

Dr. Rick W. Sturdevant, Deputy Director of History, HQ, Air Force Space Command

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In Defense of the Bush Doctrine. By Robert G. Kaufman. Lexington: The University Press of Kentucky, 2007. Notes. Appendix. Bibliography. Index. Pp. xxiv, 240. $35.00 ISBN: 0-8131-2434-6

Bush's detractors are numerous, especially within academia. It is not often that one of them would go to such length to defend Bush's doctrine, his "bold and ambitious grand strategy for waging the war on terror." Yet, this is what Kaufman attempts to do.

He notes that the Bush Doctrine includes the preemptive use of force (which must take precedence over *ex post facto* responses "when dealing with terrorists and rogue regimes bent on acquiring weapons of mass destruction"); the pursuit of regime change in the Middle East; and moral democratic realism principles, informed by cautionary tales of the past and Judeo-Christianism. On these bases, Iraq represents a correct application of the Bush Doctrine (Kaufman notes that the "defeat of radical Baathist or Islamist ideologies, menacing to millions in the Middle East and beyond, depends on the decisive use of American power"); it is the implementation that was faulty.

Moral democratic realism takes the position that while power is central to international politics, ideals, ideology, and regime type also matter. The spread of stable, liberal democracy by the U.S. ("the most successful and noble traditions of American grand strategy since Franklin Roosevelt") is, therefore, important as democracies are more likely to cooperate and remain at peace. It is also the best way to eliminate the real root cause of aggression against the U.S.: "the insidious interaction of poverty, brutality, and oppression that spawns secular and religious radicals and rogue regimes implacably hostile to the United States mainly for what it is rather than what it does." The issue for the U.S. is to spread democracy in a prudent manner, taking into account, for instance, the "imperatives of geopolitics." To Kaufman, it is this "cardinal virtue of prudence—choosing right ends and right means, [that] must guide when, how, and for what purpose the United States resorts to military force." Prudence is the standard he also uses to show that critics of the Bush Doctrine, the isolationists, realists, and liberal multilater-

alists, fundamentally got it wrong.

Kaufman's attempt to defend Bush's grand strategy can be criticized on several grounds. Its theoretical underpinnings and empirical evidence are weak. Rather than being a solidly constructed scholarly examination of the Bush Doctrine, it is more akin to an ideological essay. While the merits of the doctrine must be accepted at face value, Kaufman makes no serious attempt at critically addressing its shortfalls and tends to selectively (mis)use or oversimplify history and other schools of thought to support his argument (e.g., the views he applies to all realists, which should have been more discriminating and reflective of their individual records).

Kaufman's advocacy for the spread of liberal democracy as a key element of a U.S. grand strategy remains a bland statement that fails to recognize the preconditions necessary for democracy to flourish. Regime change through force is not an essential nor even a necessary condition in all cases. Against evidence (e.g., Northern Ireland, Italy, Greece, etc.), Kaufman wants his readers to accept the notion that democracy is an essential and sufficient condition to defeat terrorism. While liberal democracy is certainly preferable to other modes of governance, is this really achievable across the board, as Kaufman implies? His analysis is simply too faulty for the case to be made.

Stéphane Lefebvre is Section Head Strategic Analysis, at Defence R&D Canada's Centre for Operational Research and Analysis

Lockheed F–35 Joint Strike Fighter: Design and Development of the International Aircraft. By Gerard Keijsper. UK: Pen and Sword Books, 2007. Illustrations. Photographs. Appendices. Glossary. Index. Pp. 320. $45.00 ISBN: 1-84415-631-3

This book is a miniature encyclopedia of the entire Joint Strike Fighter (JSF) program from the early 1990s to mid 2007. It includes a stunning amount of detail: technical, schedule, financial, contractual, and political, and has ten pages of abbreviations—liberally used. Readers without experience in modern military aircraft development will find it heavy going, especially since Keijsper emphasizes British aspects of the program.

Despite the title, it is not limited to the F–35 JSF program. It starts with a summary of earlier Short Takeoff-Vertical Landing (STOVL) aircraft designs. Keijsper covers the origins of the DARPA-U.S. Marine Corps Advanced STOVL (ASTOVL) program. He then flows with the major program milestones, unfortunately buried deep in the text:

March, 1993: DARPA awards contracts to Lockheed Skunk Works and McDonnell-Douglas for ground tests of prototype ASTOVL propulsion systems. Loser Boeing continues on its own funds. The book covers all three projects.

1996: The Joint Advanced Strike Technology (JAST) program, started in 1994 , is merged with DARPA's ASTOVL program to form the tri-service Joint Strike Fighter program.

November 16, 1996: Boeing and Lockheed Martin selected as finalists in JSF competition to design, build, and flight test JSF tri-service prototype aircraft.

September 18, 2000: First flight, Boeing X–32A (USAF and Navy) prototype.

October 24, 2000: First flight, Lockheed Martin X–35A (Air Force) prototype

December 16, 2000: First flight, Lockheed Martin X–35C (Navy) prototype

March 29, 2001: First flight, Boeing X–32B (Marine STOVL) prototype.

June 23, 2001: First flight, Lockheed Martin X–35B (Marine STOVL) prototype

October 26, 2001: Lockheed Martin F–35 team named winner of JSF competition.

December 15, 2006: First flight of F–35A JSF production aircraft.

Keijsper provides detailed coverage of the nine military and five company test pilots who flew 283 flights on the X–32 and X–35 aircraft from September 2000 to August 2001. In the second half of the book, he includes chapters on costs, wind tunnel tests, suppliers, engines, avionics flying test beds, survivability, weapons, radar and computer systems, and current F–35 development organizations and facilities. The chapter on engines carefully details the evolution of the Pratt and Whitney F135 engine and General Electric's F136 engine. The final chapter, Export Countries, covers fifteen countries either participating in the program or considering joining. It focuses on Great Britain and The Netherlands.

One significant fact does not appear until page 189: the Lockheed patent of the Shaft Driven Lift Fan propulsion system designed for V/STOL fighter aircraft. This system was designed by Lockheed Skunk Works engineers Paul Bevilaqua and Paul Shumpert in 1989. The patent, filed in 1990 and granted in 1993, included a sketch design of a unique STOVL fighter. Initially very controversial, this propulsion system was the core of the winning X–35B design in 2001 and is now the F–35B (STOVL variant) propulsion system.

Keijsper is not bashful about making judgments. For example: "The USAF will be forced to change its flight refueling tanker fleet to the drogue system favoured by the majority of the world's air forces."

Two hundred high-quality illustrations, many in color, are a highlight of the book. Keijsper did not include either a bibliography or source document notes. Unfortunately, while the printing and binding are outstanding, the editing is not; detracting trivial details abound.

Despite endless details, this book is well worth reading for anyone interested in the origins of the F–35 JSF program and its painful, complex transformation into the largest, most internationally significant military aircraft program of the 21st century.

Sherman N. Mullin, Retired President, Lockheed Advanced Development Company, the "Skunk Works"

Surrounded By Heroes: Six Campaigns With Division Headquarters, 82nd Airborne Division, 1942-1945. By Len Lebenson. Philadelphia: Casemate, 2007. Photographs. Pp. ix, 213. $32.95 Paperback ISBN: 1-932-033-58-8

The outstanding introduction to this book rouses the reader's curiosity. Len Lebenson does a great job of portraying his Army life from the time he was drafted in September 1942. His earlier civilian experience played an important role in his military life. Lebenson's civilian typing and drafting skills provided some of the tools necessary to work his way into the G-2 section, intelligence, of the 82d Airborne Division at Ft. Bragg, North Carolina. He eventually became Operations Sergeant of the division.

From the way Lebenson describes basic training, one would think it was a lot of fun. Given my own experiences in basic, I doubt that it was as much fun as one may infer. Lebenson goes into great detail describing both his life at Ft. Bragg and the buddies who were assigned to his unit.

From Ft. Bragg, Lebenson was assigned to Camp Edwards on Cape Cod, Massachusetts. This was to be his home for only two weeks prior to departure for the war zone. From there, he and his unit moved to the port of New York and soon after left on a troop transport for North Africa. He describes in detail the living conditions and problems brought on by flies. Many troops suffered from intestinal distress. While in Africa, Lebenson had hoped to see something of the port of Algiers, however that was not to be. Soon, the unit was departing

for the invasion of Italy. All he ever got to see of Algiers was from a distance.

For the Sicily invasion, Lebenson was responsible for setting up the command post of the 504th Parachute Infantry Regiment. He quickly became "caught up" with Generals Ridgeway, Gavin, Eisenhower, Patton, and Bradley. In this environment, he quickly found out that whatever the weather conditions; the army uniform of the day was uncomfortable wool, including shirt and tie. One of the most poignant parts of this book is Lebenson's reporting that many of our airborne troops who jumped or were to jump into Sicily were killed by friendly fire.

Lebenson goes on to describe his activities and discuss operations in both Sicily and the Italian mainland until he found himself heading for Ireland and the upcoming invasion of Europe. Following his arrival in Ireland, he accompanied one of the division's colonels to England to set up billeting in England during the build-up of troops. He landed with the initial assault force in Normandy. His service carried him from battle to battle from France to Holland to the Ardennes and finally into Germany. Along the way, he developed great relationships with both officers and enlisted men. It is particularly evident that he greatly admired both Generals Gavin and Ridgeway. He returned to New York and his family in 1945.

I was particularly interested in this book since it allowed me to compare his experiences in an Army command post with mine during my Air Force career when I served as Superintendent of my wing command post. The book is interesting and easy reading and provides a lot of insight into the operations and inner workings of one of the most famous of the Army's World War II divisions.

Stu Tobias, Indianapolis, Indiana

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Harrier II: Validating V/STOL. By Lon O. Nordeen. Annapolis, Md.: Naval Institute Press, 2007. Maps. Photographs. Illustrations. Notes. Appendices. Bibliography. Index. Pp. xii, 149. $28.95 Paperback ISBN: 1-55125-114-0

My interest in V/STOL aircraft started, in a somewhat roundabout fashion. In Southeast Asia. I often looked out at rows and rows of revetted aircraft and thought, "Man, if the Bad Guys land one in the center of our runway, all that aluminum sitting out there is gonna be totally worthless. There's got to be a better way." The second time V/STOL caught my attention was in the 1970s at Yokota AB, Japan. I was heading off-base after a duty shift when I saw a jet, apparently out of control, about to crash into our passenger terminal. As I jammed on the brakes, the "out of control" airplane came to a stop and slowly settled down to a landing on the other side of the building. I had met my first Harrier.

This is Nordeen's fourth book about modern air warfare. Right off the bat, his subtitle, caught my attention. I don't believe the "Vertical" part of V/STOL has been validated with this aircraft, as the amount of fuel expended to vertically lift a fully loaded Harrier into the air seriously limits the aircraft's range and, therefore, usefulness. Strangely, Nordeen doesn't pursue the Harrier's vertical takeoff problems. STOL, however, is a completely different story, and he covers this aspect of the Harrier very well indeed.

In his preface Nordeen stresses that the book will be a review of the history of the AV-8B Harrier II program, but thankfully he then devotes the first quarter of the book to a history of the Hawker Aircraft P1127/P1154 prototypes, the early AV-8A and Harrier programs, and even gives us a short course on the modern requirements of Marine Corps air support (viz, if you can't get support to the grunt's fight within 10 minutes or so, it's usually too late).

This book is a thoroughly enjoyable look at the Harrier II program. It provides interesting insights into the minds of some of the visionaries, civilian and military, British and American, who made this trouble-plagued aircraft into the success it is presently enjoying today as a "commander's choice" in the War on Terror. Nordeen fully explains the bird's amazing ability to use 2000 feet (or less) of un-pre-targeted, pre-existing roadways (or small ships) to deliver useful/lethal combat loads, whilst having superbly quick turn-around times. His description of the evolution of Harrier combat tactics is most interesting and informative.

However, more space should have been devoted to the Harrier's detractors and some of the aircraft's real shortcomings. The major complaint voiced by some authors and politicians was that the USMC wasn't using the Harrier II tactically as a V/STOL aircraft, but rather as a STOL weapon system. The answer may be, "So what?" Tactics evolve; and, if the Corps could get the fantastic turn-around times they did in the Gulf Wars using the bird in the STOL mode, so much the better. Some people, who really should know better, have voiced reservations about the need for the Harrier because they feel that 10,000 ft. concrete runways will always do the trick; will always be in place where our forces need them; and will always be in a country that, with arms wide open, will let us in. They may need to wake up and look at the real world.

It would have also been interesting to know why the Harrier II suffered so many crashes, especially in American hands. A perusal of the appendices shows that, of the 363 American AV-8Bs tracked in this book, close to 24 percent of them were lost in Class A mishaps (severe crashes). Why was this accident rate so high? Conversely, for the British versions (GR5/7/9), the accident rate for the 109 airframes tracked came out to only 11 percent. Why was the British Class A rate significantly so much lower? These questions remain unanswered.

Overall, though, Nordeen has provided Harrier aficionados and tactical aviation buffs a good and interesting book that, for the present, stands at the forefront of this most interesting and valuable aircraft's history.

MSgt. Tom Teliczan, USAF (Ret.), Mililani, Hawaii

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Hiroshima: The World's Bomb. By Andrew J. Rotter. New York and London: Oxford University Press, 2008. Photographs. Notes. Bibliography. Index. Pp. viii, 371. $29.95. ISBN: 0-19-280437-2

Heavens! Another book on atomic bomb development and use in World War II. Especially one by another professor of history with little grounding in either physics or military operations. Because of my immersion in the *Enola Gay* and related topics at the National Air and Space Museum, I still felt I had to grab up this latest effort in the field to see what new material I could glean. There wasn't much that I hadn't seen before. Disappointing? Absolutely not. Although there is nothing new from primary sources such as the National Archives, recently opened Soviet files, or other potential wells of new knowledge, Professor Rotter has done something that I wasn't sure could be done. He has synthesized a lot of the great works on the subject of the bomb into a relatively short and very readable single volume while raising a number of moral issues that should give any reader something to chew on.

Hasegawa's *Racing the Enemy* is a 375-page book. Rhodes' *Making of the Atomic Bomb* tops out at nearly 900 pages. Skates' *The Invasion of Japan* is shorter at only 270 pages. Rotter lists many other books in his extensive notes and biblio-

graphic essay. Most of them I've read, and most of them are excellent. But that is a lot of reading for someone who would like to learn about the overall story of the bomb's development, its combat use, and the politics surrounding the bomb and the war's end. Rotter very well captures the essence of all of these in one book.

The only great source he missed is Coster-Mullen's definitive work on the weapons, *Atom Bombs*. This led to some unfortunate errors about the technical side of the bomb: "Little Boy . . . was 14 feet long, 5 ft in diameter . . ." (actually 10 ft. and 28 in. respectively). "Its proximity fuse" (it used a radar altimeter arrangement). "A 30,000-pound bomb had exploded . . " (either its weight of 9700 lbs or equivalent TNT energy of 30 million lbs/15 kilotons).

Other errors crept in as well: "Over a fourteen-hour period on the 14th and 15th [August 1945], 828 B–29s and 186 fighters bombed and blasted Tokyo." The last mission over Tokyo was on August 10th, and there were never 828 B–29s over any target—or even in the air at the same time. And then there is the classic, *Bock's Car* error for *Bockscar*. These detract from the book for anyone who is familiar with the technical and operational aspects of the story but not from the overall presentation.

So what has Dr. Rotter presented? First, this is far more than a World War II story. He, like Rhodes, covers the history of nuclear physics from its advent through the Manhattan Project. He covers the people who made the bomb possible in this country and who failed to make it a reality in both Germany and Japan. All the while, the reader is constantly led to one of Rotter's main theses and one that everyone who studies Manhattan must understand: the bomb was not just an American product. Rhodes brought this out and so does Rotter. It was British, Hungarians, Italians, Danes, Americans, and many others who worked together to make the bomb a reality.

But Rotter goes much further in the nuclear story than other authors. He continues with developments after the war through to the present: development of the H-bomb by the US, Soviet efforts to make first an A-bomb and then their own H-bomb, and the work in every other nuclear power (including one that developed a bomb and then abandoned it, South Africa). However, his first chapter may be what I found most intriguing. Here he reflects on the ethical role of scientists and examines the role of science in another moral controversy of twentieth-century war, the use of poison gas. At the other end of the book, he looks at terrorism and concludes his thoughts on the moral use of weapons that were raised in a number of areas of the text. I found the material to be very thought provoking.

The works of Alperovitz or Tibbetts, or a number of others who have written on this topic, generally leave the reader with no question about which "side" of the nuclear issue that author supports. I'm not really sure how Rotter feels about some of these issues because he presents them from several points of view—in my humble opinion, the mark of a great professor who allows the "student" to think about the material and arrive at his or her own conclusions.

In short, if anyone asks me to recommend a book about the advent of the atomic bomb, in the past I would generally refer them to Rhodes. Not now. This is the book to start with. For the reader who wants more, there are Rotter's many other cited sources to explore after getting the basics from *Hiroshima: The World's Bomb*.

Col. Scott A. Willey, USAF (Ret.), Book Review Editor

Bader's Last Fight: An In-Depth Investigation of a Great WWII Mystery. By Andy Saunders. London: Grub Street, 2007. Maps. Illustrations. Photographs. Appendices. Bibliography. Index. Pp 160. $39.95 ISBN: 1-904943-96-9

In this book, Andy Saunders discusses the events surrounding Sir Douglas Bader's last combat sortie and works to solve a long standing mystery. While leading part of air escort for Circus 68 (bombing raid into France hoping to draw Luftwaffe activity) on August 9, 1941, Bader parachuted from his stricken Spitfire and was captured by the Germans. Was he shot down? Was he brought down by a mid-air collision? And who did it? Switching between second and third person, the author uses an investigative approach of addressing each issue regarding the fateful mission and works to bring the reader to specific logical conclusions regarding each issue and thus to the ultimate conclusion of what happened.

Sadly, this book misses the mark on many accounts. While Saunders points out that the book is not a Bader biography, he repeatedly inserts jabs at the man's character: the flight where he lost his legs being an unauthorized display, referring to his leadership skills as perceived, apparent disdain towards enlisted aviators, and portraying Bader as bent on increasing his own kill total. The accuracy or validity of these points is not the issue. As presented, they detract from the main focus of the book and add nothing to solving the mystery of Bader's downing.

The book suffers from disjointed organization. Sixteen chapters each analyze some aspect of the event. Rather than grouping RAF or Luftwaffe views, or chronologically focusing chapters, Saunders bounces between the two and often veers off point. For example, while discussing Adolf Galland's memories of events, Saunders inserts Johnnie Johnson's observations.

Saunders relies heavily on Paul Brickhill's biography, *Reach for the Sky*, for Bader's point of view. But he focuses on pointing out errors in that book, devoting an entire chapter to discussing it. He then uses these "errors" as the basis to question Bader's motives and memory of events. Furthermore, Saunders notes how Bader's account in his autobiography, *Fight for the Sky,* differs from Brickhill's account. In a footnote, he refers to one point both as "changed slightly" and a "significant variation" but never fully explains this. Saunders doesn't use the autobiography and doesn't list it in the bibliography despite the above reference. For a book attempting to be exceptionally thorough in its analysis, this omission is very glaring.

Saunder's analysis is suspect. For example, in a discussion on G forces, he points out that "his lack of lower limbs may well have been a physiological disadvantage" but fails to explain what the disadvantage would be. He then uses the temporary loss of memory from "graying out" (which occurs as positive G forces cause blood to pool in the lower extremities) to explain why Bader's memory while experiencing negative G's (which causes red out's as blood pools in the eyes) while trying to bail out, is suspect and should, thus, be discounted.

Finally, the most glaring error in the analysis is the non-inclusion of the RAF's own report concerning potential fratricide during Circus 68. Saunders simply states, "The evidence is there for all to read at the national archives in Kew." Since the report isn't in the bibliography, it is unclear if Saunders even used it. Saunder's conclusions are subject to question.

Bader's Last Fight misses the mark. Omissions, a pervasive undercurrent of Bader bashing, disjointed organization, and lightly supported grand leaps in logic leave the reader certain only that Bader failed to return from his last sortie. The cause remains an open question.

Lt. Col. Daniel J. Simonsen, USAF, Commander AFROTC Detachment 305, Louisiana Tech University, Ruston, Louisiana

Apollo Moon Missions: The Unsung Heroes. By Billy Watkins. Lincoln: University of Nebraska Press, 2007. Maps. Tables. Illustrations. Photographs. Notes. Appendix. Glossary. Bibliography. Index. Pp. xxiv, 202. $17.95 paperback ISBN: 0-8032-6041-2.

Most books about Apollo focus on a small number of individuals. But beyond the astronauts, engineers, and NASA executives who were the public face of the program, Apollo was a vast undertaking that, at its peak, involved over 400,000 people. Watkins acted upon an idea from Apollo 16 astronaut John Young, who suggested that a book be written about some of the less-well-known people who helped get the astronauts to the Moon and back. Watkins tells the stories of 14 individuals (symbolically, one for each astronaut who set foot on the Moon or was expected to do so): their backgrounds, how they came to NASA and Apollo, the roles they played in the program, and their current reflections on Apollo.

The people Watkins writes about are not heroes in the conventional meaning of the word, for they did not accomplish great feats by putting their lives at risk. But Watkins's unstated message is that we should take a broader view and think of a hero as someone who acts with exceptional dedication to achieve an important goal that goes beyond his or her own interests.

One of the more interesting stories is about Joe Laitin. NASA had decided to take the bold step of launching only the second manned flight of the program, Apollo 8, to the Moon. Frank Borman, Apollo 8 commander, recognized the flight's historic significance and wanted to come up with just the right words to say from lunar orbit. For help, he contacted Si Bourgin, a public affairs officer he had worked with on NASA goodwill tours. Bourgin in turn called on Laitin, a long-time friend from their days as columnists and magazine writers in Hollywood.

Laitin wasn't even a NASA employee but was voluntarily helping the program. When told Apollo 8 would orbit the Moon on Christmas Eve, he decided that Borman's comments should be "something Biblical." The New Testament story of Christmas didn't have the right words. After he struggled for several hours, his wife suggested he look in the Old Testament instead. He copied the first several verses from the Book of Genesis and sent the text off to Bourgin, who passed it to Borman. Then, on Christmas Eve, Borman and crewmates Jim Lovell and Bill Anders give their individual impressions of the Moon, followed by a three-man reading of the text Laitin had provided. That reading, along with the dazzling "Earthrise" photograph taken by Anders, has become one of the lasting memories of the Apollo program.

Other subjects include Steve Bales, a young guidance officer in Mission Control who had 15 seconds to decide whether to abort Apollo 11's lunar landing when an alarm sounded while Armstrong and Aldrin were descending to the surface. Richard Underwood and Julian Scheer argued successfully to convince mission planners that television and still cameras be taken on the lunar missions. Another is JoAnn Morgan who, as a new college graduate, became the first woman to work in the Apollo firing room at Cape Canaveral.

Unfortunately, the book suffers from disappointingly poor fact checking. For example, Watkins says the flotation collar placed around the Apollo 11 command module (CM) to keep it afloat during recovery was intentionally punctured and allowed to sink into the sea after the crew was taken aboard the recovery helicopter. In fact, the collar remained attached and is displayed at the National Air and Space Museum. But the book is about people, not procedures and other technical matters. So, the technical errors detract only slightly from book's value. All in all, the book is a great read and should be on the bookshelf of any fan of the space program.

Lt. Col. Joseph Romito, U.S. Army (Ret.), Docent, National Air and Space Museum

The History of Air Intercept (AI) Radar and the British Nightfighter, 1935-1959. By Ian White. UK: Pen and Sword, 2007. Maps. Tables. Diagrams. Illustrations. Photographs. Notes. Appendices. Glossary. Bibliography. Index. Pp. ix, 326. £25.00 ISBN: 1-84415-532-3

This book is an outstanding combination of the many aspects involved with air intercept radar. It recounts many of the technical aspects of the development of these units, testing of the equipment, installation in various aircraft, development of tactics, and operation in combat.

Ian White is retired from British Telecom and spent much of his career working on air defense and military communications. He has previous publications dealing with the history of the Royal Air Force's (RAF) No. 604 Squadron; the origins and development of Identification, Friend or Foe (IFF) during World War II; and the Fairey Firefly nightfighter. As demonstrated by the range of these topics, the author is very successful in blending technical, operational, and military aspects of the subjects into a very interesting book.

The story is obviously told from a British point of view. This is probably appropriate since the British led in the development of radar. The narrative starts with the development of radar itself in the 1930s, concentrating on the numerous models of airborne radar that saw production and use during the war, and then continues into the immediate postwar years when the RAF maintained a fighter-based air defense against the Soviet manned bomber threat as part of NATO.

White also touches on efforts in the United States to develop airborne radar, in particular those efforts that involved cooperation with British scientists and military personnel. This aspect of the book highlighted to me the degree of cooperation and trust that existed between the British and the US during the war, such as the sharing of key secrets of technological breakthroughs and the use of common equipment by both countries' air forces. White also demonstrates how well bureaucratic red tape can be cut through after the shooting starts.

In addition to the text, the book is well supplied with additional information in the form of six appendices. White provides a 12-page primer on the basics of radar. This should prove to be useful to those lacking knowledge of this subject. He also provides a detailed section on the various types of RAF aircraft that were used as nightfighters and their various models of air intercept radars, complete with performance specifications and silhouettes. There are also tables detailing all Luftwaffe aircraft destroyed at night over Great Britain during the war, and a listing of all nightfighter squadrons and the airfields from which they operated from 1939 to 1959.

Even though this book deals with a very specialized topic, I found it very interesting and well written. Fighter pilots and electronic warfare specialists should find the book particularly interesting, but anyone who wants to know more about this particular technology and its application during World War II and the early Cold War will enjoy it as well.

Col. Stetson M. Siler, USAF (Ret.)

Books Received

Fields, Kenny Wayne. *The Rescue of Streetcar 304: A Navy Pilot's Forty Hours on the Run in Laos*. Photographs. Pp. xviii, 311. $19.95 Paperback ISBN: 1-59114-271-3

Gill, John H. *1809, Thunder on the Danube: Napoleon's Defeat of the Hapsburgs—Volume I: Abensberg*. London: Frontline Books, 2008. Maps. Tables. Diagrams. Illustrations. Photographs. Notes. Bibliography. Index. Pp. xvi, 496. £30.00 ISBN: 978-1-84415-713-6

Gooderson, Ian. *A Hard Way to Make a War: The Italian Campaign in the Second World War*. London: Conway, 2008. Photographs. Notes. Appendices. Bibliography. Index. Pp. 352. £20.00 ISBN: 978-1-84486-059-3

Heaton, Colin D. and Anne-Marie Lewis. *Night Fighters: Luftwaffe and RAF Air Combat over Europe, 1939-1945*. Annapolis, Md.: Naval Institute Press, 2008. Maps. Photographs. Notes. Appendices. Bibliography. Index. Pp. xiv, 188. $27.95 ISBN: 978-1-59114-360-4

Kaplan, Philip. *Fighter Aces of the RAF in the Battle of Britain*. UK: Pen & Sword Aviation, 2007. Photographs. Index. Pp. x, 203. £19.99 ISBN: 978-1-84415-587-3

Laver, Harry T. and Jeffrey J. Matthews, Eds., *The Art of Command: Military leadership from George Washington to Colin Powell*. Lexington: The University Press of Kentucky, 2008. Photographs. Notes. Bibliography. Index. Pp. xvi, 276. $32.50 ISBN: 978-0-8131-2513-8

Leger, Philippe. *Du Kanister au jerrycan: 70 ans de service/From Kanister to Jerry Can: 70 Years of Service*. Heimdal, 2008. [French/English text] Illustrations. Photographs. Bibliography. Pp. 159. $39.95 ISBN: 978-2-84048-244-4

Merlin, Peter W. and Tony Moore. *X-Plane Crashes: Exploring Experimental, Rocket Plane, and Spycraft Incidents Accidents and Crash Sites*. North Branch, Minn., 2008. Photographs. Appendices. Pp. 16o. $29.95 ISBN: 978-1-58007121-5. Order on-line at www.specialtypress.com

Peary, Alan McGregor. *From North Africa to the Arakan: The Engrossing Memoir of a World War II Spitfire Ace*. London: Grub Street, 2008. Photographs. Appendices. Index. Pp. 222. £20.00 ISBN: 978-1-906502-03-4

Percy, Algernon. *A Bearskin's Crimea: Colonel Henry Percy VC & His Brother Officers*. UK: Leo Cooper, 2005 [an imprint of Pen &Sword]. Maps. Photographs. Notes. Appendices. Glossary. Bibliography. Index. Pp. xxix, 238. £12.99 Paperback ISBN: 978-1-844156-43-6

Polak, Tom *et al*. *No 310: (Czechoslovak) Squadron, 1940-1945*. UK: 2008. Maps. Tables. Diagrams. Illustrations. Photographs. Notes. Appendices. Glossary. Bibliography. Pp. 98 Paperback £19.00 ISBN: 978-2952-638111

Polak, Tom *et al*. *No 312: (Czechoslovak) Squadron, 1940-1945*. UK: 2008. Maps. Tables. Diagrams. Illustrations. Photographs. Notes. Appendices. Glossary. Bibliography. Pp. 98 Paperback £20.00 ISBN: 978-2952-638159

Rielly, Robin L. *Kamikazes, Corsairs, and Picket Ships: Okinawa, 1945*. Philadelphia and Newbury, UK: Casemate, 2008. Maps. Tables. Diagrams.

PROSPECTIVE REVIEWERS

Anyone who believes he or she is qualified to substantively assess one of the new books listed above is invited to apply for a gratis copy of the book. The prospective reviewer should contact:

Col. Scott A. Willey, USAF (Ret.)
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Fairfax, VA 22033
Tel. (703) 620-4139
e-mail: **scottwille@aol.com**

* Already under review.

Illustrations. Photographs. Notes. Appendices. Glossary. Bibliography. Index. Pp. xii, 435. $34.95 ISBN: 978-1-932033-86-1

Rodrigues, Rick. *Aircraft Markings of the Strategic Air Command, 1946-1953.* Jefferson, N.C. and London: McFarland & Co., 2006. Diagrams. Illustrations. Photographs. Notes. Appendices. Bibliography. Index. Pp. ix, 269. $85.00 ISBN: 978-0-7864-2496-2

Smith, Claude. *The History of the Glider Pilot Regiment.* UK: Pen & Sword Aviation, 2008. Maps. Illustrations. Photographs. Bibliography. Index. Pp. 204. $24.95 Paperback ISBN: 978-1844156-26-5

Vacher, Polly. *Wings around the World: The Exhilarating Story of One Woman's Epic Flight from the North Pole to Antarctica.* London: Grub Street, 2008. [First published in 2006.] Maps. Tables. Diagrams. Illustrations. Photographs. Index. Pp. 160 £12.99 Paperback ISBN: 978-1-904943-99-0

Y'Blood, William T. *Air Commandos against Japan: Allied Special Operations in World War II* Burma. Annapolis, Md.: Naval Institute Press, 2008. Maps. Tables. Diagrams. Illustrations. Photographs. Notes. Appendices. Glossary. Bibliography. Index. Pp. xii, 302. $36.95 ISBN: 978-1-58114-993-4

The President's Message

October 6th—our long-anticipated day—turned out to be a big winner in many exciting ways. During the early afternoon, we had a very productive meeting of the Board of Directors. The Board meeting was followed by an Ops Talk, a sort of old fashioned beer call. (A special thanks to Lockheed-Martin for their support of this event.) Lt. Gen. Dave Deptula, Deputy Chief of Staff, Intelligence, Surveillance, and Reconnaissance, shared with us his views on current Air Force issues and stayed to answer questions. General Deptula hit a homerun with his candor and clarity of expression, and I'm certain we'll repeat it in the future.

After the Ops Talk, we hosted a reception and honored four recipients of our most prestigious awards. (See a more thorough report on the next page.) Finally, Gen. Ronald R. Fogleman, the former Air Force Chief of Staff (1994-1997) finished the evening with an inspiring message.

As my wife, Barbie, and I wrapped up some personal farewells and headed home, we reflected on the excitement and sense of satisfaction on the part of all who pulled off this miracle of many moving parts. I congratulate and thank most specifically our Executive Director, Col. Tom Bradley, and Office Manager, Mrs. Angela Bear, for their extraordinary efforts. Others also played crucial roles: Maj. Gen. Si Johnson, who chaired the Development Committee, deserves special applause for his aggressive and successful campaign to obtain corporate support for this event as well as for all our work. (The list of contributing corporations appears on page 2.) Incidentally, the Air Force Sergeants Association provided elegant banquet programs to all attendees at no cost.

This is my last message to you as President of the Foundation. After more than five years in the chair, I will retire on December 31st. It has been a task of personal passion for me, as I truly believe in the Foundation's purpose and promise. I'm happy that we are managing to add modest initiatives, while keeping our heads above budget water (though the collapse of the stock market has hurt us as it has you) with prospects for continued corporate support. We are also focused on what we want to do to further our impact. At the top of the list is the project to archive our fifty-five years of magazine articles in searchable format, which should get my successor—not yet named—off to a good start.

I am particularly pleased and grateful that we have such an active and committed Board, which now numbers eighteen. Most of them work full time using their discretionary hours to help us. We installed and welcomed the class of 2011, including two new members: USAF retirees Col. Dick Hellier and Maj. Gen. Mike De Cuir. I thank and wish well the two whom they succeed, Lt. Gen. Marv Esmond and Col. Darrel Whitcomb.

I'll wake up in January and miss the challenge, I know. Still it's time for someone else to inject new thinking and energy into this great organization. I thank most sincerely my colleagues and friends, Tom Bradley and Angela Bear, without whose work we would be helpless and hopeless. I also thank Jack Neufeld, the hard-working, selfless, skillful editor of our magazine *Air Power History*, the longtime pillar of our Foundation, for issue after issue of excellence. Most of all, I thank our loyal members; with your support we can think of our work as "mission possible." Please continue your commitment to the Air Force and the Foundation—and spread the word.

Farewell and best wishes to all.

Cheers, Mike

Air Force Historical Foundation 2008 Awards Banquet

The Air Force Historical Foundation held its annual awards banquet on October 6, 2008, at the Sheraton Crystal City Hotel in Arlington, Virginia. The evening's activities began with the "Ops Talk," an informal discussion on current Air Force issues and operations by Lt. Gen. David A. Deptula, Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance, HQ USAF. He engaged a group of about 100 with a very interesting talk and answered questions. A reception afterwards allowed attendees to mingle with friends and view the award trophies that were presented at the dinner.

The banquet began with presentation of the colors by an element of the USAF Honor Guard and the singing of the national anthem by MSgt. Matthew Irish of the USAF Band. Foundation President and Chairman of the Board, Lt. Gen. Michael A. Nelson, made some opening remarks before dinner was served. After the meal, General Deptula presented the "Best Air Power History Book Award" to Col. Stephen P. Randolph, USAF (Ret.), PhD, for *Powerful and Brutal Weapons: Nixon, Kissinger, and the Easter Offensive* (Cambridge, Mass: Harvard University Press, 2007). The panel that selected this book wrote that it "describes the North Vietnamese 1972 spring offensive, and the Republic of Vietnam's and the United States' reactions to it from political and military angles. The book has been meticulously researched, thoroughly documented, articulately written, is solidly objective, and strategic."

Next, Col. Dick Anderegg, USAF (Ret.), Director of Air Force History and Museums Plans and Programs, presented the "*Air Power History* Best Article Award" to Lt. Col. Donald R. Baucom, USAF (Ret.), PhD, for "Wakes of War: Contrails and the Rise of Air Power, 1918-1945," published in *Air Power History*, Summer and Fall 2007.

General Ronald R. Fogleman, USAF (Ret.), the former Air Force Chief of Staff (1994-1997) presented the second annual Maj. Gen. I. B. Holley Award for "sustained, significant contributions to the research, interpretation, and documentation of Air Force history" to Brig. Gen. Alfred F. Hurley, USAF (Ret.), PhD, who chaired the U.S. Air Force Academy's Department of History for fourteen years, was President and Chancellor of the University of North Texas for eighteen years, and Chancellor of the University of North Texas System for two years. He then took emeritus status and returned to the classroom as Professor of History for five years. He recently retired from that duty.

Then, General Nelson presented the second annual General Carl A. "Tooey" Spaatz Award "for sustained, significant contributions to the making of Air Force history" to Maj. Gen. John R. Alison, USAFR (Ret.), who worked with the Royal Air Force and the Soviet air forces on Lend-Lease activities prior to America's entry into World War II, served with Lt. Gen. Claire Lee Chennault's Flying Tigers, and later in the war was Deputy Commander of the First Air Commando Force. He continued his service at high levels in both military and civilian government assignments through the 1970s.

General Fogleman delivered the keynote address, a discussion of the broad influence of military history and its relevance to combat operations in the modern era.

Finally, in a surprise presentation, General Fogleman and long-time Foundation member and Director Maj. Gen. Charles D. Link gave General Nelson a gift signifying the end of his term of more than five years as President and Chairman of the Foundation. The two Board members unveiled a large crystal model of the Air Force Memorial, and they presented a spray of roses to Mrs. Barbie Nelson.

The nomination period is now open for Foundation members to name candidates for the third annual Spaatz Award and the third annual Holley Award. Qualification details are available on the Foundation's Web site, WWW.AFHISTORICALFOUNDATION.ORG and nominations may be made by mail or e-mail to the Foundation staff through April 2009.

Winners of the Foundation's Highest Awards

General Fogleman (left) presents the Maj. Gen I.B. Holley Award to Brig. Gen. Al Hurley.

Lt. Gen. Nelson (right) presents the Carl A. "Tooey" Spaatz Award to Maj. Gen. John Alison.

Lt. Gen. David Deptula (left) presents the "Best Air Power History Book Award" to Col. Steve Randolph. Before the banquet, Lt. Gen. Deptula described current USAF operations and answered questions at the Ops Talk.

Colonel C. R. Anderegg, (left) head of the Air Force History and Museums program presents the "Best Article Award" to Lt. Col. Donald Baucom.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

(Required by 39 USC 3685)

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Dr Alfred F. Hurley	Mr Jacob Neufeld	None
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	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
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(1) Mailed Outside-County Paid Subscriptions Stated on PS Form 3541	1939	1976
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(3) Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS	61	64
(4) Paid Distribution by Other Classes of Mail Through the USPS (e. g., First-Class Mail)	2882	2951
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i. Percent Paid (15c Divided by 15f Times 100)	89%	91%

16. Publication of Statement of Ownership: This statement will be printed in the December 2008 issue of the publication.
17. Signature and Title of Editor, Publisher, Business Manager, or Owner: I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties). (*Signed*) Tom Bradley, Executive Director, Air Force Historical Foundation, October 1, 2008.

News

The Tuskegee Airmen Inc., Howard Baugh Chapter, has commissioned artist Joel Randell to sculpt a one and a quarter life-size bronze statue of their namesake and Petersburg, Virginia, native. The Tuskegee Airmen debunked the myth that blacks were inferior pilots. Four hundred and fifty black pilots flew combat missions through the Tuskegee program, over 100 made the ultimate sacrifice in training and combat, and another thirty-two were held as prisoners of war.

Colonel Baugh flew 135 combat missions as part of the 99th Fighter Squadron and 332d Fighter Group in Sicily and Italy. In January 1944, over the Anzio beachhead, Baugh along with his wingman were credited with a victory for shooting down a German FW-190 fighter-bomber. Baugh continued his military career after the war and retired with a Distinguished Flying Cross, the Air Medal with three Oak Leaf clusters, the Air Force Commendation Medal, and the Air Force Outstanding Unit award, to his credit. In June 2004, the French government presented Baugh with one of its most prestigious awards, the Legion of Honor.

Joel A. Randell, a professional figure and portrait sculptor, has sculpted approximately 350 bas-relief bronze portraits, including one of Charles B. Hall, exhibited at Tinker Air Force Base, Oklahoma City, Oklahoma.

Have something to say?

Readers are encouraged to submit letters to the editor on any topic or issue covered in Air Power History.

E-mail:
Jneufeld@comcast.net
or send letters to:
Air Power History
11908 Gainsborough Rd.
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THANK YOU, REVIEWERS. *Once every year, it's been my custom to acknowledge the help of several individuals, without whose assistance I could not possibly produce this journal. They are: Brig. Gen. Alfred A. Hurley, USAF (Ret.), publisher; Dr. Richard I. Wolf, layout, typesetting, and chief collaborator; Col. Scott A. Willey, USAF (Ret.), book review editor; David Chenoweth, photo and illustrations resource; Robert F. Dorr, writer/editor of the "History Mystery"; Col. Tom Bradley, USAF (Ret.), circulation and advertising; and Angela Bear, office manager and administrator extraordinaire. Welcome this year to Eileen DeVito and her spouse, Richard DeVito, who volunteered to proofread, saving us from countless embarrassments. In addition to these "regulars," I also send out manuscripts to several highly respected and knowledgeable peer reviewers. These individuals critique submissions and make recommendations regarding publishability. Thank you.*

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Our book reviewers are also a talented and expert band of individuals who love to read the latest air and space history literature. Several are authors themselves and, hence, know the historiography of their subjects. They provide guidance on the strength or weakness of new books and back up their estimations. Thank you, thank you.

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Maynard Y. "Bing" Binge
1920-2008

Lt. Col. Maynard Yocum "Bing" Binge, USAF (Ret.), a longtime Air Force Historical Foundation member, trustee, supporter, and executive director (1997-2000), died on September 28, 2008.

He was born on January 20, 1920, in Galva, Illinois. After graduating from Galesburg Senior High School in 1937, he attended the University of Illinois, Florida State University, and graduated from the University of Maryland in June 1967 with a BS degree. He earned an MBA in 1975, an MA in Personnel Management in 1976, and an MA in Public Administration in 1978 from Central Michigan University.

"Bing" was drafted into the U.S. Army in September 1941, and completed basic training at Ft. Sill, Oklahoma. In June 1942, he transferred to the Air Corps received an Aviation Cadet appointment, and entered Preflight Training (Class 43E). He received Primary Flight Training at Chikasa, Oklahoma, Basic at Enid, Oklahoma, and Advanced (twin engine) at Pampa, Texas. He was commissioned as a second lieutenant and rated as a pilot in May 1943.

Colonel Binge was assigned to the 20th Fighter Bomber Wing, Shaw AFB, South Carolina, in 1950, and awarded a Senior Pilot rating in June. In 1958, after completing a tour at RAF Station Wethersfield, England, he received the rating of Command Pilot. He was promoted to lieutenant colonel in 1964 and assigned to the Pentagon the following year.

Placed on active flying status in 1968, he was stationed at Nah Trang, South Vietnam. During the war he flew 837 combat hours and 141 missions in EC–47 aircraft. In November 1969, he returned to the U.S. and was assigned to Air Force Systems Command. Colonel Binge retired in 1973.

His decorations include: the Distinguished Flying Cross; Air Medal, with five oak leaf clusters; Meritorious Service Medal: Air Force Commendation Medal; Presidential Unit Citation; American Defense Service Medal; American Campaign Medal; World War II Victory Medal; National Defense Service Medal; Vietnam Service Medal; Air Force Longevity Medal; Air Force Reserve Forces Medal; Republic of Vietnam Air Medal; Republic of Vietnam Cross of Gallantry with palm.

In December 1973, as a civil service senior management analyst, he worked in Air Force Systems Command headquarters. In 1981, he was assigned to the Air Staff. He retired from the civil service in 1986.

During his early retirement years, he was a senior technical editor for Applied Ordnance Technology. He also volunteered to assist Colonel George Johnson, vice president and founder of AFROC, until Falcons Landing opened in May 1996. Bing also served as Secretary of AFROC's Board of Directors.

After a brief period as a special projects manager in 1996, he was appointed executive director of the Air Force Historical Foundation. He remained in that position until he resigned in December 2000, due to the exhausting daily 80-mile round-trip commute from home to office.

Bing is survived by his wife, Audrey; daughter, Kay Haskins; grandson Gary Haskins; and brother, Willard Binge.

History Mystery

by Robert F. Dorr

Our Fall 2008 "History Mystery" aircraft was the Sikorsky MH–53M Enhanced Pave Low IV special operations helicopter. The U.S. Air Force retired its last MH–53M on September 30, 2008. This series began as the Vietnam-era "Super Jolly Green," whose original job in the Air Force was combat rescue. The Air Force followed the Marine Corps with its version, the CH–53A Sea Stallion, which made its maiden flight on October 14, 1964.

In November 1966, the Air Force borrowed two CH–53As from the Marines. Soon after, the Air Force purchased eight combat-rescue HH–53Bs. They became known as "Super Jolly Greens," since they were larger than the HH–3E helicopter nicknamed the "Jolly Green Giant."

The Air Force HH–53B made its first flight on March 16, 1967, and reached Southeast Asia in October 1967. In his book, *Search and Rescue in Southeast Asia* (Center for Air Force History, 1992), historian Earl H. Tilford, Jr., wrote: "The HH–53B/C represented the best in rescue technology, yet there were limitations. Too large to be an ideal rescue helicopter, its size kept it from maneuvering in tight areas like karst valleys. [It was] an easy target for enemy gunners."

Tilford credits H–53s with 371 of the 2,039 combat rescues made in Vietnam. H–53B/C helicopters participated in the attempt to rescue American prisoners of war in the Son Tay raid of November 1970. In 1969, an HH–53B was tested with a night/all-weather rescue system known as Pave Low I, which was not successful.

The Air Force's 6594th Test Group at Hickam AFB, Hawaii, used HH–53Cs to retrieve film packages dropped from orbit by reconnaissance satellites. In 1968, the HH–53C also supported Apollo space missions. The Air Force also acquired thirty CH–53C cargo haulers, which lacked armor and guns.

The H–53s were powered by two T64-GE-7 turboshaft engines. The first generation of H–53 helicopters gave way to the HH–53H Pave Low II, MH–53J Enhanced Pave Low III, and MH–53M Enhanced Pave Low III. Last issue's photo, by Tech Sgt. John Hickman, depicted MH–53M 68-10357, which was retired to the National Museum of the Air Force last April. Aircraft 68-10357's final flight was a combat mission in Iraq March 28, after which it was brought home via cargo aircraft.

Our "History Mystery" winner, among the thirty-three readers who identified the MH–53M correctly, is James Curran of Chicago.

This Issue's Mystery Plane

Can you identify our latest "mystery" aircraft? Enter our contest and find out.

1. Submit your entry on a postcard to Robert F. Dorr, 3411 Valewood Drive, Oakton VA 22124. Entries may also be submitted via e-mail to robert.f.dorr@cox.net.

2. Name the aircraft shown here. Include your postal mailing address and telephone number.

3. We'll choose a winner at random from among correct entries and send the winner a copy of *Hell Hawks*, our newly published history of a P–47 Thunderbolt fighter group.

This feature needs your help. Do you have a photo of a rare or little-known aircraft? We'll return any photos provided for use here.