The Path Taken ...

Army Space technology beginnings

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By Bernard Kerstiens

Department of Defense (DoD) Space efforts can be divided into four basic areas: Space support, force enhancements, Space control, and Space applications. In each of these key areas, the Army has a rich history and has made significant contributions.

Space Support — it does take a rocket scientist

Collectively, the technologies required to achieve and sustain Space operations in orbit are referred to as Space support. This includes the launch, tracking, control, and satellite bus. The Army's historical role in Space support is probably the one most often chronicled.

The Army's development of launch capabilities by the Von Braun team at Redstone Arsenal, Ala., is the best known. The Army Ordnance Corps started long-range surface-to-surface guided-missile research with Cal Tech in a remote area outside of Pasadena, Calif., in May 1944. These facilities were the beginnings of the Jet Propulsion Laboratory (JPL). In less than a year, the contract for the Hermes project was given to General Electric and in February 1945, Bell Laboratories received a contract for the Nike project. These two missiles became the progenitors of many of the Army's contributions to the application of "rocket science."

While JPL was at the heart of the Army's research in long-range rockets, the Army's fiscal investments were small, late, and disorganized in comparison to the activities of a group of scientists in Germany. Prior to World War II, the German scientists at Peenemuende had the finances and organization to conduct a rapid succession of experiments to perfect weapons (such as the V-2 rocket) capable of delivering a high explosive payload at distances up to 300 kilometers. These scientists created production and engineering facilities designed to manufacture more than 600 V-2 rockets a month by the end of World War II. This feared weapon of war captured the imagination of the world and inspired rocket research worldwide.

Mr. Rocket comes to America

In an attempt to dismantle the Nazi war machine and to prevent the revival of Nazi war potential by the transfer of its economic and industrial capital, the British and U.S. military collaborated in a plan know as Eclipse. This plan implemented the U.S. State Department's Safehaven project, focusing on the non-proliferation of German nuclear weapon expertise. These efforts spawned Project Paperclip, which sought out strategic centers of German scientific knowledge to provide "proper and permanent control" of them in the best interest of "world security." One of the individuals who supervised Project Paperclip was COL H. N. Toftoy (also know as "Mr. Rocket"). It was his relentless pursuit of rocket expertise that brought the Von Braun team to the United States. By May 1948, Project Paperclip had brought 492 German specialists to the United States: 177 with the Army, 205 with the Air Force, 72 with the Navy, and 38 with the Department of Commerce (under Army custody).

With the delivery of 121 German rocket scientists and 300 freight cars of V-2 components to Fort Bliss, Texas, high-altitude scientific experiments and transfer of German rocket expertise began. The German scientists commented just after World War II that the American capabilities in 1945 were approximately 10 years behind the level of German expertise. Over the next few years, 52 V-2 rockets were fired from White Sands Proving Grounds (WSPG) and the Florida Missile Testing Range, the last one on June 28, 1950.

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The Army has been a leader in Space research throughout the 20th century as evidenced by numerous technology firsts and capability demonstrations. The Army is now continuing this heritage in the 21st century in accordance with new DoD guidance and emphasis on Space dominance and operations. Space has evolved from a mission of achieving the "high ground" to one of extending power/might and providing global capabilities to the individual Soldier. It will be imperative to protect and secure these Space capabilities for our future national defense needs.

These series of tests helped facilitate the technology transfer of German "know how."

In February 1949, the Bumper Round 5 Missile, fired at WSPG under Von Braun's direction, was the first penetration of Space by a U.S. missile. Project Bumper was a modified V-2 that accommodated a WAC (without attitude control) Corporal (developed by JPL) to test multistage rocket flight and separation. It also tested second-stage ignition in rarefied air. The Bumper test achieved a 250-mile height to make the Army the first to place an object in Space. The Army, working with the Navy, collaborated on a number of upper atmospheric tests and even launched a V-2 from the deck of an aircraft carrier. The Navy was so interested in the upper atmospheric test that it pursued the Viking missile to continue scientific research when the V-2 stockpile was depleted.

On Oct. 28, 1949, the Army's Ordnance Research and Development (R&D) Division at Fort Bliss was transferred to Redstone Arsenal, Ala. At Redstone, the Von Braun team started work on missile improvements conceived at the end of World War II. Building on the Hermes C-1 rocket, it developed what later became known as the Redstone rocket.

On Feb. 1, 1956, the Army established the Army Ballistic Missile Defense Agency (ABMA), to which the Secretary of Army delegated unparalleled procurement authority. ABMA brought together the unprecedented combination of German creativity and U.S. Army ordnance production capabilities. The Von Braun team's unity of purpose allowed ABMA to remain at the forefront of U.S. rocket R&D.

Redstone Arsenal's initial proposal to manufacture the Redstone missile by using its own R&D shops was denied. Because of delays at the contractor's facilities, the Arsenal ended up building the first 12 Redstone missiles as well as missile numbers 18 through 29. This fabrication experience created a virtual "skunk works" that was fully capable of readily modifying the Redstone missile for various configurations and payloads. The Army joined with the Navy to propose launching a satellite with a Redstone missile under Project Orbiter. But in 1955, the government elected to pursue a less military-related effort under project Vanguard. Vanguard was based on using the Navy's Viking missile to boost an upper atmosphere scientific payload. The Navy's Vanguard project was under contract to the Martin Company and funded by National Science Foundation. The Vanguard project, however, was doomed because Martin received a more lucrative Titan missile contract from the Air Force, causing redirection of limited talent and resources.

The Army began work on a 1,500-mile range intermediate range ballistic missile (Jupiter C missile) to support sea and land requirements on Feb. 1, 1956. To pursue the development of the Jupiter C missile, ABMA became a Class II activity. On Aug. 8, 1957, the nose cone of a Jupiter C missile was successfully recovered. The nose cone success is attributed to German scientist creativity and was accomplished on one-tenth of the budget that the Air Force expended under its nose cone research efforts.

The Oct. 4, 1957, launch of the Russian Sputnik I, followed by Sputnik II on Nov. 3, 1957, unleashed the Army's R&D expertise at Redstone Arsenal to launch the first U.S. satellite (Explorer I). A series of Army "first in Space" events unfolded:

- Explorer I was launched on Jan. 31, 1958, as part of the International Geophysical Year. It was a 30.8-pound satellite that carried a cosmic ray detector, a cosmic dust gauge, thermometers, and microlock and minitrack transmitters. This payload led to the discov-

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ery of the Earth's Van Allen radiation belts.

· Explorer II failed to make orbit on March 5, 1958, because of a fourth-stage failure. The satellite carried a cosmic ray counter, an erosion gauge, a thermometer, and microlock and minitrack instrumentation.

· Explorer III was launched on March 26, 1958, and carried a similar payload to Explorer I. However, it also included a miniature tape recorder to record radiation data between ground stations.

· Explorer IV was launched July 26, 1958, and carried four radiation counters. Explorer V failed to make orbit because of a collision between the first stage and upper stages.

ABMA continued to provided launch service to Advanced Research Projects Agency (ARPA) and the National Advisory Committee on Aeronautics (1915-1958 — forerunner to National Aeronautics and Space Administration (NASA)), including the first two lunar probes.

On Aug. 15, 1958, ARPA Order 14-59 initiated the Army's Juno V booster program. This program started what became known as the Saturn booster.

On July 1, 1960, ABMA and its facilities at Redstone Arsenal and Cape Canaveral, Fla., were turned over to NASA. The Army retained work on the Pershing and Nike missile systems as well as the Army Rocket and Guided Missile Agency that became part of the Army's Aviation and Missile Command.

Another Army installation rich in Space history is Camp Evans (near Fort Monmouth, N.J.). On Jan. 10, 1946, scientists working on Project DIANA were the first to bounce radio signals off the Moon. This experience led the Army's Signal Corps and the Signal Research and Development laboratory (SRDL) team (which also received German scientists through Project Paperclip) to become involved with the operation and maintenance of primary tracking and telemetry ground stations of the Vanguard minitrack network. SRDL later helped calibrate the minitrack system by using its Project Diana radar facilities.

The United States was unprepared to track the Sputnik satellite even though the Russians had previously announced the satellite frequency. Fort Monmouth rapidly found equipment through the recapitalization of military receivers and was credited with having provided the backbone of the entire U.S. tracking and observation efforts for Sputnik. This effort became the Signal Corps AstroObservation Center.

The SRDL tracked solar cell development from its beginnings at Bell Laboratories in 1954 and pressed the Navy to include solar cells on the Vanguard satellite.

Space Force Enhancement

While the Army was very much involved in the development of Space support technology, it was also deeply involved in Space force enhancement. Space force enhancement operations improved the warfighting force via Space capabilities. Traditionally, Space force enhancement includes command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR); position/navigation; and meteorological monitoring.

In June 1958, SRDL at Fort Monmouth initiated fabrication of a 150-pound communication satellite to be completed in 60 days under Project SCORE (signal communication by orbiting relay equipment). The ARPA-sponsored project provided for a launch on an Air Force Atlas intercontinental ballistic missile (ICBM). On Dec. 18, 1958, the SCORE satellite was the first to relay, store, and forward human voice and data. The satellite also broadcasted President Eisenhower's Christmas message to the world.

The work on the SCORE satellite generated another sophisticated 500-pound relay communication SRDL satellite named Courier. The first Courier 1A satellite failed to make orbit (Aug. 18, 1960), but the second Courier 1B satellite was placed in low earth orbit on Oct. 4, 1960. It was the first communication satellite to be powered by nickel cadmium batteries and recharged by solar cells. After completing one orbit, it relayed a message from President Eisenhower to the United Nations, transmitted from Fort Monmouth and relayed to Puerto Rico.

The TIROS (television and infrared observation satellite) was launched on April 1, 1960. TIROS evolved from Major General Medaris' "eye in the sky" concept at ABMA. ABMA and the Signal Corps developed the TIROS I and II satellites and Fort Monmouth provided satellite control and ground stations for the TIROS satellites. NASA directed the overall operational phase after ARPA sponsorship was transferred.

The Army Advent Management Agency had the lead for communication satellite development under ARPA's Project Advent. The Army was the lead in the development of ground stations and payloads, the Navy was lead on shipboard terminals, and the Air Force was responsible for launch. After a year, the Air Force was successfully able to argue that satellites were part of its mission and the Army responsibilities were reduced to ground terminals and ground support. In 1962, the Army established the U.S. Army Satellite Communications Agency.

The Army developed most of the ground stations and payload control for the SYNCOM III satellites. From 1964 to 1969, the U.S. Army Corps of Engineers pioneered the development of a series of very accurate geodetic satellites named SECOR (sequential collation of range), which related local map data to a global grid. Position errors were less than 10 meters and it had similar techniques as today's global positioning system to deal with ionospheric diffraction.

In the early seventies, the Nixon administration revised DoD Directive 5160.32 to allow each Service to conduct Space R&D for "unique battlefield and ocean surveillance navigation, communication, meteorological, mapping, charting, and geodesy satellites." This allowed the Army and Navy to once again start investigating and exploiting Space capabilities.

During this time, the national strategic Space systems were providing capabilities used by the national decision makers and strategic planners. The tactical user had no, or at best very limited, information from the national Space systems. The Army established the Army Space Program Office (ASPO) in 1973 to rectify this deficiency. ASPO developed means to rapidly exploit national Space information in theater and link this product to tactical users.

The Assistant Secretary of the Army requested that a technology manager of Space R&D programs be established to provide an internal and external focus to the Army. The Army Space Technology and Research Office (ASTRO) was created on Jan. 6, 1988, to fill this role. The ASTRO mission was later transferred to the U.S. Army Space and Missile Defense Command (SMDC) to consolidate Space-related activities in the Army. ASTRO efforts later became the Space Application Technology Program.

The Army Space Institute under the direction of Vice Chief of Staff General Thurman initiated what became the Army Space Exploitation Demonstration Program (ASEDP) to be executed by U.S. Army Space Command (ARSPACE). ASEDP was able to demonstrate multiple Space exploitation capabilities and research opportunities for the Army. ASEDP maintained a close relationship to SATP within SMDC.

Space Control

Space control, defined as ensuring the freedom of action in Space for the United States and its allies while denying the enemy the use of Space, is another area where the Army has a long history of significant contributions. When the Russians threatened the West with an orbital H-bomb on Aug. 9, 1961, all three Services initiated R&D efforts.

The Army's program, code-named Mudflap, was based upon the Nike missile. The missile's capabilities were extended via anti-ballistic missile (ABM) research to a Nike Zeus configuration. In May 1962, the U.S. Army fielded the first operational anti-satellite weapon (ASAT) base at the Kwajalein Missile Range (KMR). After an ASAT policy meeting in June 1963, the Army was directed to complete the ASAT facilities at KMR, including storage of the system's nuclear warheads. In 1966 the program was phased out.

In the late 1980s, the Army initiated a new R&D program with a kinetic energy (KE) ASAT system leveraging ongoing ABM development exoatmospheric re-entry-vehicle interceptor system. But by the mid-1990s, with the fall of the iron curtain, the requirement for KE ASAT no longer existed.

The Army conducted a series of data collection exercises in the late 1990s using the mid-infrared advanced chemical laser at the High Energy Laser Test Facility at White Sands Missile Range, N.M., on cooperative Space targets.

The Army is now investigating nondestructive technologies to secure Space superiority for its future forces.

Space Application

Space application is the fourth key area in which the Army has a rich history of making significant contributions. Space application describes the projection of force (i.e., intercontinental ballistic missiles) and defense from, through, and in the Space environment. Accordingly, almost all established Space launch capabilities in the area of Space application trace their beginnings to the nuclear missile arms race.

Besides the missile developments conducted at Redstone Arsenal, re-entry-vehicle development was also pursued. The Army flew the successful nose cone test on May 15, 1957, with only one-tenth of the budget of the Air Force. On Aug. 8, 1957, a nose cone was recovered and later displayed by President Eisenhower to demonstrate that Army scientists had successfully solved the problems associated with ballistic missile re-entry.

The work of the Army also led the Services in missile defense. Through the 1960s, the Nike family of missiles evolved with ever-greater capabilities (Nike, Nike Zeus, and Nike X). The Sentinel system had two nuclear-tipped missiles: the Spartan was exoatmospheric and the Sprint was endoatmospheric. Also during the 1960s, the Nixon administration reformulated the ABM mission and renamed it Safeguard. Safeguard was operational less than a year when Congress closed the program in accordance with the ABM Treaty. ABM activities were limited to research by the Army Ballistic Missile Defense Agency. The ABM mission was transferred to the Strategic Defense Initiative Organization (SDIO) in 1985. The Army still actively conducts missile research and its current customer is the Missile Defense Agency, SDIO's successor organization.

Conclusion

The Army has been a leader in Space research throughout the 20th century as evidenced by numerous technology firsts and capability demonstrations. The Army is now continuing this heritage in the 21st century in accordance with new DoD guidance and emphasis on Space dominance and operations. Space has evolved from a mission of achieving the "high ground" to one of extending power/might and providing global capabilities to the individual Soldier. It will be imperative to protect and secure these Space capabilities for our future national defense needs. The battlefield has already been transformed by Space capabilities such as satellite communications and GPS. The future battlefield will continue to change as new Army-developed technologies are applied to Space and provide capability to both the National Command Authorities and to the warfighter.

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Space Soldiers in Action

l-r, CPT Bob Barrett, SGT Sabrinna Bannister, SSG Greg Singer, and CPT Angela Johnson set up a dish that provided Space support to the 1st Marine Expeditionary Force during Operation Iraqi Freedom.
Photo by MAJ Daniel Cockerham