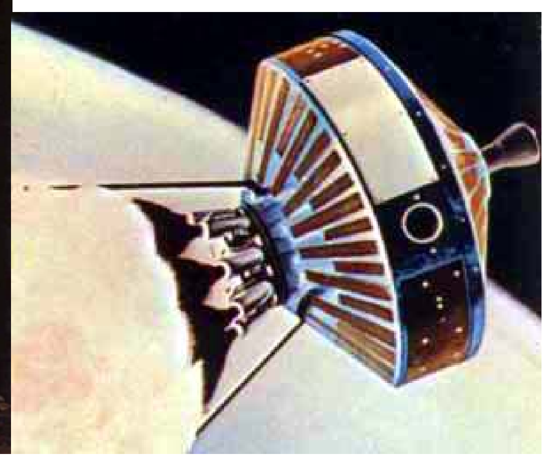
CHAPTER VII: OTHER PROGRAMS

Pioneer Lunar Missions

The first Air Force spacecraft to be launched and the first space missions to be actually carried out by the Air Force were the Pioneer lunar probes of 1958. They were also the world's first attempted deep space or lunar probes; the first program to receive direction from the Advanced Research Projects Agency when it was created in 1958; and among the first space programs to be transferred to the newly created National Aeronautics and Space Administration. The Thor Able launch vehicle which these missions employed was the first step in the development of the Delta vehicle.

Left: The Thor Able Launch Vehicle for Pioneer 1 stands on the pad at Cape Canaveral before launch on 11 October 1958.
Below right: An artist's concept depicts the fourth stage spacecraft and propulsion assembly developed by STL for the Air Force Pioneer lunar missions.



In January 1958, the Air Force Ballistic Missile Division (AFBMD) and its technical advisory contractor, Space Technology Laboratories (STL), proposed using the newly developed Thor missile with the second stage of the Vanguard[50] rocket to launch the first missions to the moon. The new launch configuration was named the Thor Able. The stated purposes of the missions were to gather scientific data from space and to gain international prestige for America by doing so before the Soviet Union. After the Eisenhower administration activated the Advanced Research Projects Agency (ARPA) on 7 February 1958, the new agency's first directives to the military services dealt with lunar probes. AFBMD was to launch three lunar probes using the Thor Able configuration; the Army Ballistic Missile Agency (ABMA) at Redstone Arsenal, Alabama, was to launch two lunar probes using its Juno II vehicle; and the Naval Ordnance Test Station (NOTS)

[50] Vanguard was a three-stage launch vehicle and small scientific satellite developed by the Naval Research Laboratory. It made the first attempt to launch a U.S. satellite on 6 December 1957 but exploded on the pad. However, it successfully launched the second U.S. satellite on 17 March 1958.

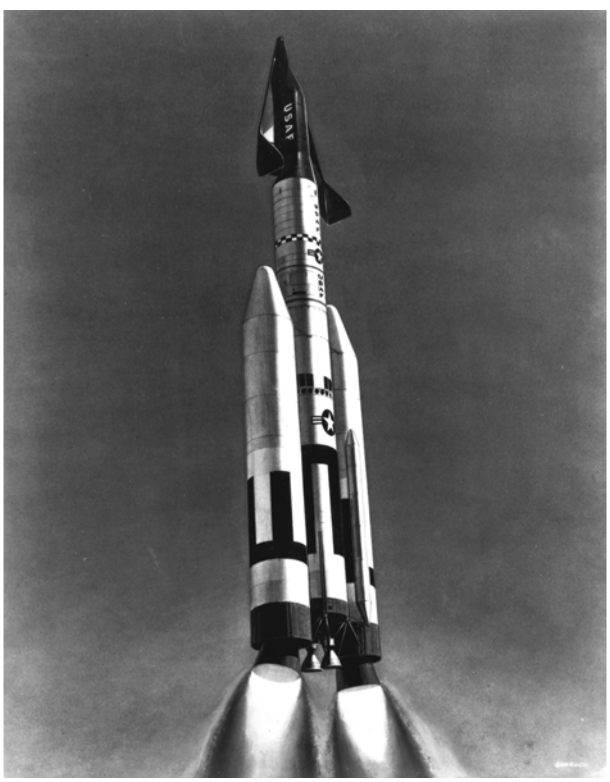
at China Lake, California, was to provide a miniature imaging system to be carried on the lunar probes.

STL designed and assembled the spacecraft and experiments in its R&D Facility, now Area A of Los Angeles AFB, and it assembled and tested the upper stages and spacecraft in the Ramo-Wooldridge hangar at Los Angeles International Airport. Each spacecraft contained experiments to measure the earth's and moon's magnetic fields, the intensity of radiation fields in space, and the number and intensity of micrometeorites, as well as a scanner able to return a rudimentary image of the moon at closer range.

AFBMD launched its lunar probes—known as Pioneer 0, 1 and 2—on 17 August 1958, 11 October 1958, and 8 November 1958. Unfortunately, the first and third probes suffered launch failures, and the second traveled only 71,700 miles into space, about a third of the way to the moon. Nevertheless, Pioneer 1 (the second probe) returned much useful scientific information, especially about the extent of the Van Allen Radiation Belts, and can be considered the world's first successful deep space probe. The Army's second lunar probe, Pioneer 4, actually achieved escape velocity and flew by the moon after launch on 3 March 1959. By then, however, the Soviet Union's Luna 1 spacecraft had already achieved the first successful lunar flyby on 4 January 1959.

Manned Orbiting Laboratory

Although most manned space programs were assigned to NASA in 1958, the Air Force retained a modest effort to explore the potential of manned military missions in the upper atmosphere and near-earth orbit. It was known as the Dyna-Soar or X-20 program. Development of the aerodynamic, manned vehicle was managed by Wright Air



Left: An artist's concept of the Dyna-Soar system depicts the Titan IIIC launch vehicle developed by AFBMD and the manned, aerodynamic vehicle developed by Wright Air Development Center. The program was canceled in 1963 before flying any hardware, but AFBMD and its successors proceeded to develop the Titan IIIC into one of the most important launch vehicles in the Air Force inventory.

Development Center at Wright Patterson AFB. Development of the launch vehicle, which became the Titan IIIC space booster after several changes in requirements, was managed by AFBMD. When President Johnson's Defense officials decided that the missions envisaged for Dyna-Soar could be performed better by NASA's Gemini capsules or something like them, the program was canceled on 10 December 1963. At the same time, Secretary of Defense Robert S. McNamara announced the beginning of a program to develop an orbiting laboratory module for manned military space missions. The module would be called the Manned Orbiting Laboratory (MOL), and it would provide a shirt-sleeve environment in which military astronauts would be able to conduct experiments in near-earth orbit for up to thirty days.

Right: An artist's concept of the Manned Orbiting Laboratory (MOL) in orbit. The white, cylindrical element was the laboratory itself; the darker element was a Gemini capsule that would be used to bring astronauts to the lab and return them to earth after their mission was over.

General Schriever, by then commander of Air Force Systems Command, assigned the management of all manned military space programs, including MOL and its launch vehicle, to Space Systems Division. SSD issued contracts for the preliminary design work to Boeing, GE, Douglas, and Lockheed on 1 March 1965. On 25 August 1965, President Lyndon B. Johnson announced that he had approved a development plan for MOL that would cost about $1.5 billion. Douglas Aircraft Company would design and build the spacecraft under SSD’s management, and it would be launched by a new configuration of the Titan IIIC launch vehicle to be called the Titan IIIM. Unfortunately, the program experienced delays, weight and cost increases, and changes in mission, launch site, and launch vehicle. Its only launch occurred on 3 November 1966, when a MOL heatshield incorporating a hatch cover survived a suborbital reentry test on a Gemini capsule. On 10 June 1969, the Office of the Secretary of Defense (OSD) announced the cancellation of the program because of high projected cost increases and because advances in automated, unmanned space systems made it unnecessary. By the time the program was canceled, work was almost finished on construction of a new launch site for the program's Titan IIIM booster at Vandenberg AFB. That launch site was modified ten years later for the Space Shuttle, and it was modified again during 2002-2003 for launches of the Delta IV Evolved Expendable Launch Vehicle.

This group photo, taken in 1968, shows 14 of the 17 MOL astronauts. The first group of eight astronauts was selected in November 1965, the second group of five in June 1966, and the third group of four in June 1967. Following cancellation of the MOL program, seven of the former MOL astronauts became astronauts for NASA, and three later attained general officer or admiral rank. James Abrahamson (top right) became a lieutenant general and Director of the Strategic Defense Initiative Organization. Robert Herres (top left) became a four-star general and Commander-in-Chief of the U.S. Space Command. Richard Truly (bottom right) became a vice admiral and head of the U.S. Naval Space Command. After retiring from the Navy, Admiral Truly joined NASA, serving first as Associate Administrator for Space Flight and later as Administrator.

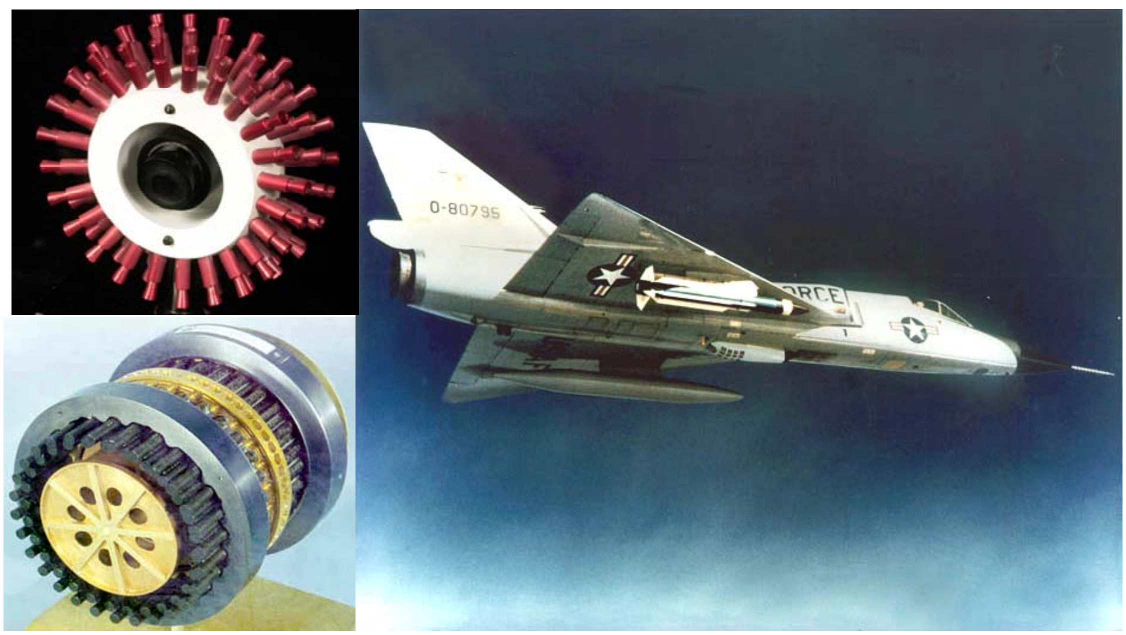
Antisatellite Systems

The nation's first operational antisatellite weapon system was known as Program 505. It was developed by the U.S. Army, using Nike Zeus missiles originally designed for an anti-ballistic-missile role. The Army based the missiles on Kwajalein Atoll in the Pacific, conducted tests, and declared the system operational on 1 August 1963. Secretary of Defense McNamara at first kept the system on alert but abandoned it in favor of the Air Force’s antisatellite system in 1964.

The Air Force’s antisatellite system was brought into being by Space Systems Division during late 1963 and early 1964. A ground-based system known as Program 437, it employed Thor missiles with nuclear warheads which could be shot into space accurately enough to destroy or disable a hostile space-based weapon or satellite. Secretary of Defense McNamara approved the system's development on 20 November 1962. Thor boosters were modified, combined with ground equipment from deactivated Thor missile sites in England, and deployed to Johnston Island in the Pacific. There they were maintained and operated entirely by Air Force military personnel. Four test launches without live warheads took place, the first on 1 February 1964. Only three of them were successful, but the system was declared fully operational on 1 June 1964, with Air Defense Command as the using command. The capability remained in place, though with few dedicated launchers and a temporary loss of warheads, until it was placed on 30-day standby status on 2 October 1970. The launch facilities on Johnston Island were deactivated on 1 April 1975, and the program was abandoned entirely.[51]

While it was still active, however, SSD added a satellite-inspection capability to the system. On 23 May 1963, SSD's higher headquarters, Air Force Systems Command, ordered studies of the possibility of using Program 437's assets to inspect and photograph hostile satellites on orbit. SSD developed such a system, known as Program 437AP (for Alternate Payload), and conducted several test launches from 7 December 1965 through 2 July 1966. Some of the tests were successful in returning photographs of the targeted Agena spacecraft. The system employed cameras and recovery capsules developed by the Corona program. Nevertheless, the Air Force canceled Program 437AP on 30 November 1966.[52]

During the 1970s, SAMSO began to develop a concept for a follow-on antisatellite weapon system that would not use nuclear warheads. The weapon was actually developed in two successive, related efforts. The first effort was known as Project Spike. It involved launching a two-stage missile from an F-106 aircraft. The missile would release a terminal homing vehicle guided by solid rocket motors on a trajectory to intercept the selected satellite, which it would destroy by impact. The program conducted a static flight test with the ARM missile, fitted with a dummy



The two contractors involved in Project Spike, General Dynamics and Ling-TEMCO-Vought (LTV), designed very different miniature homing vehicles. A plastic model of General Dynamics' vehicle, known as the Gimbaled Miniature Vehicle, is shown at top left. A plastic model of LTV's vehicle, which ultimately became the concept for the later Air-launched ASAT, is shown at bottom left. The vehicles were designed to be launched from an F-106 fighter using a standard Anti-Radiation Missile (ARM) shown under the right wing of the F-106 above. Both were designed to destroy a satellite by impact. The many thrusters on both vehicles were necessary to balance them and adjust their trajectories in flight.

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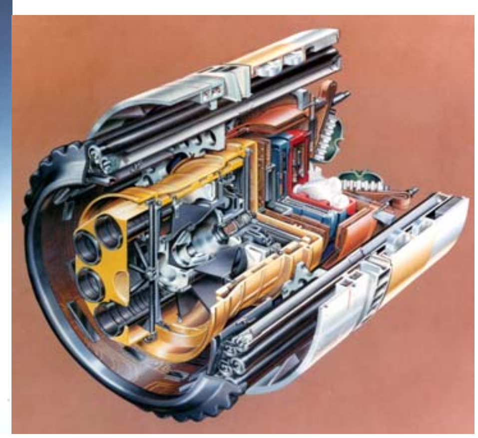
[51] Clayton K.S. Chun, Shooting Down a "Star": Program 437, the US Nuclear ASAT System and Present-Day Copycat Killers, Air University Press, April 2000.

[52] Much of the information about ASAT programs was provided by Major General Thomas P. Taverney.

payload representing the homing vehicle, mounted on a special rack on the F-106.

Project Spike did not enter the development stage, but its technology and design provided the basis for a later antisatellite development program known as the Air-launched ASAT, which SAMSO began to develop in 1976.[53] Like Project Spike, the Air-launched ASAT employed a miniature homing vehicle propelled into space by an air-launched two-stage missile, although in this case the missile was released from an F-15 fighter. The miniature vehicle used a longwave infrared sensor to acquire its target, steered toward the target by selectively firing small rocket motors, and destroyed the target by force of impact. The system achieved a high degree of technological success. Its first free-flight test on 21 January 1984 was successful, although its second test on 2 November 1984 was not.[54] Finally, on 13 September 1985, the ASAT successfully carried out its only flight test against an orbiting satellite,[55] which it destroyed by impact. Despite some further successful testing, the Air-launched ASAT program was terminated by the Air Force on 14 March 1988 because of Congressional restrictions against testing and budgetary constraints.

Left: The Air-launched Antisatellite missile is released from its F-15 launching aircraft and its motor is ignited. At a certain point in its trajectory, the missile released a miniature homing vehicle which destroyed the satellite by impact. Below: A cutaway view of the ASAT's miniature homing vehicle. The rockets were mounted in an outer ring around the vehicle, and the infrared seeker assembly was in the center.



[53] The program was authorized by President Gerald Ford's National Security Decision Directive 333. See David N. Spires, Beyond Horizons, Air Force Space Command and Air University Press, revised edition, 1998, p. 188.

[54] The first free-flight test did not include a miniature homing vehicle. The second test used a star as a target for the homing vehicle's sensor.

[55] The satellite used as a target was P78-1, an experimental satellite launched in 1979 by SAMSO's Space Test Program.

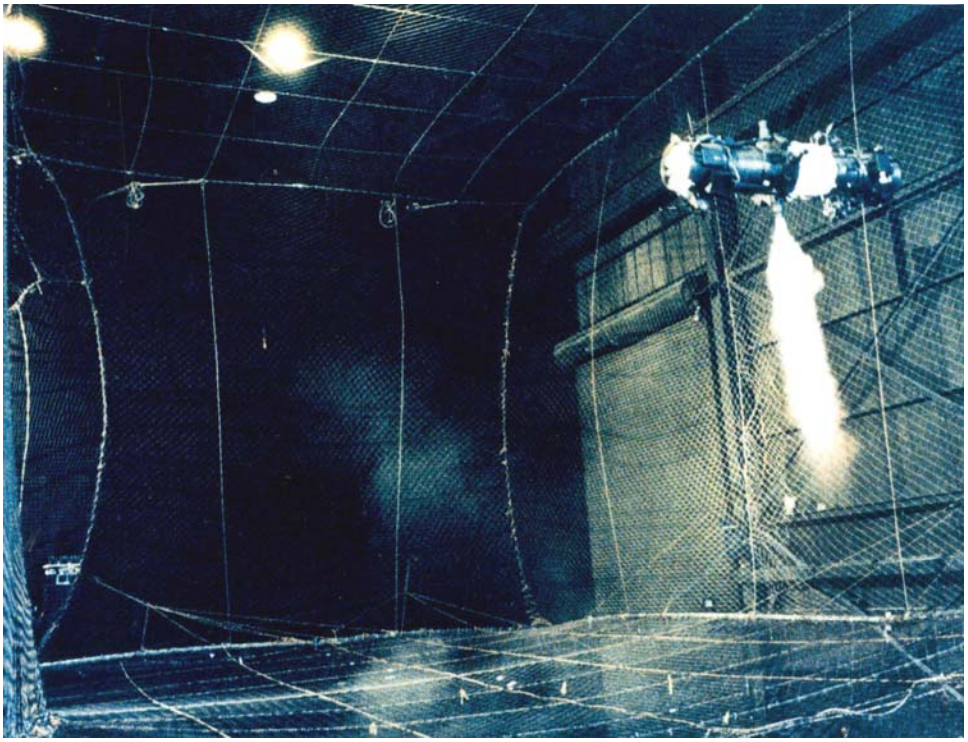
Ballistic Missile Defense

In 1983, DOD began work on developing a national defense against ballistic missiles. Originally, the effort was known as the Strategic Defense Initiative (SDI) and was directed primarily at strategic missiles launched by the Soviet Union. By the early 1990s, however, the Cold War was winding down, and certain third-world countries were posing a new threat, exemplified by the Scud missiles launched by Iraq in the Persian Gulf War of 1991. In response to the change in circumstances, the missile defense effort was redirected toward a more limited protection of U.S. territory, troops and allies from the more limited threat posed by third-world ballistic missiles. The new overall concept was called Global Protection Against Limited Strikes (GPALS), and the Strategic Defense Initiative was renamed Ballistic Missile Defense (BMD).

Included under the umbrella of SDI, and later BMD, were programs for surveillance systems to detect and track enemy missiles and for directed and kinetic energy weapons to destroy those missiles. Funding and direction for these programs came from OSD's Strategic Defense Initiative Organization (SDIO), later renamed the Ballistic Missile Defense Organization (BMDO) and later still the Missile Defense Agency (MDA). Space Division was involved in the earliest studies and continued to execute the major programs assigned to the Air Force. On 5 August 1987, the Defense Acquisition Board selected three of SSD's programs for demonstration and validation: the Boost Surveillance and Tracking System, which would track enemy missiles in the early phase of their ballistic trajectory; the Space Surveillance and Tracking System, which would track them in the mid-course phase of their ballistic trajectory; and the Space-Based Interceptor, an orbiting, rocket-propelled weapon system that would destroy enemy missiles by impact. These systems were expected to become part of the first phase of a Strategic Defense System. As the overall concept for that system evolved, the three programs were affected in different ways.

The Space-Based Interceptor (SBI) system was to consist of groups of interceptors housed in orbiting modules with housekeeping and battle functions. In 1990, the SDIO decided to pursue an alternate system based on a weapons concept called Brilliant Pebbles, which would consist of many highly autonomous interceptors floating independently in orbit. Development of Brilliant Pebbles was transferred from the BMDO to SMC in FY 1993. By that time, however, the program was being cut back, and it was terminated in 1994 as interest shifted away from defense against strategic missiles and toward defense against theater ballistic missiles launched by third-world countries. In August 1994, OSD approved a concept for a Boost Phase Interceptor (BPI) that would respond to the new threat. It endorsed a BPI technology demonstration led by the Air Force, and SMC was to manage the program and acquire the BPI missile. Congress appropriated funding for the BPI for 1995, but future funding support from the Air Force and BMDO appeared uncertain.

The SDIO's decision to replace the SBI system with a system using many highly autonomous interceptors affected the Boost Surveillance and Tracking System (BSTS) as well as SBI. The independent targeting capabilities to be incorporated into each autonomous interceptor reduced the SDIO's requirements for separate systems of sensors such as BSTS, and management of BSTS was therefore transferred to the Air Force. As



A partially successful hover test of a laboratory model of the Space-Based Interceptor (SBI) is conducted at the Air Force Astronautics Laboratory, Edwards AFB, California, in November 1988. This pre-prototype interceptor was demonstrated successfully in three series of SBI hover tests at the Astronautics Laboratory. The first series tested the interceptor's guidance and propulsion systems. The second series demonstrated the ability of the interceptor's integrated seeker assembly to lock on to a thrusting rocket plume and then shift its aimpoint from the hot, bright plume to the relatively cold, dim body of the rocket. This was a critical and previously unsatisfied requirement for any anti-ballistic-missile weapon system using infrared seekers. The last hover, the only one in the third series, took place on 10 April 1992. It tested a vehicle that was partially miniaturized and much closer in weight to an operational interceptor. The hover accomplished almost all of its objectives despite an anomaly late in the test. The SBI pre-prototype interceptor became the pre-prototype for the SDIO's preferred space-based weapon system, Brilliant Pebbles, which was terminated in 1994 for lack of funding.

an Air Force program, the system would improve upon and replace the existing DSP system. It would detect and track enemy missiles but would not have to provide extremely accurate targeting information that would allow kinetic or directed energy weapons to shoot the missiles down.

After being transferred to the Air Force, BSTS was renamed the Advanced Warning System (AWS) and then the Follow-on Early Warning System (FEWS). In November 1993, the FEWS program was canceled and replaced with a cheaper alternative called the Alert Locate and Report Missiles (ALARM) program. Before the ALARM program could really get started, however, it was replaced in its turn by the Space-Based Infrared System (SBIRS).[56]

Unlike BSTS, the Space Surveillance and Tracking System (SSTS) remained an

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[56] For an overview of the family of infrared detection programs known as SBIRS, see the section called Infrared Early Warning Systems under Chapter V, Satellite Systems, earlier in this history.

SDI program, but it went through several restructurings and changes in concept. The program's flight experiments were canceled, and its planned constellation of satellites became smaller and cheaper. In July 1990, the SDIO renamed the program Brilliant Eyes, and Brilliant Eyes became a far simpler system as interest shifted from protection against Soviet strategic missiles toward protection against shorter range, third-world missiles. In FY 1995, funding for Brilliant Eyes was reduced, and the program's development efforts were cut back. However, plans called for SBIRS satellites in low earth orbit to use Brilliant Eyes technologies to track missiles in the middle portion of their trajectories.

Space Test Program

The Space Test Program (STP) provided space flight opportunities for research and development payloads sponsored by DOD agencies that did not have their own funds to develop, launch, and operate spacecraft. Each year, the Air Force Secretariat convened the Space Experiments Review Board (SERB), comprised of voting members from all DOD agencies. The SERB reviewed requests for space flights and produced an annual list of requests that it had approved, arranged in order of priority for available flights. Each year, STP flew as many SERB payloads as possible, considering priority, opportunity, and funding. SMC and its organizational predecessors had managed STP for DOD since the program officially began in 1965.

Space Systems Division first set up an office for planning and coordination of flights for space experiments on 1 December 1963. An important consideration in planning for such flights was the fact that the new Titan IIIC launch vehicle (which made its first flight on 18 June 1965) would soon provide more opportunities for launching secondary payloads. As the most powerful launch vehicle in the inventory, it would be capable of launching more and heavier payloads on each mission than it was then scheduled to carry. In view of that, a memorandum of 6 May 1965 from the Director of Defense Research and Engineering asked the Air Force to identify experiments worthy of including in the new vehicle’s multiple payload dispensers. On 12 July 1965, General Schriever, then commander of Air Force Systems Command (AFSC), ordered the establishment of a command program managed by SSD to rank all experiments whose sponsors proposed to use the excess payload capacity of the new Titan IIIC. AFSC expanded the types of launch vehicles that would be used in the program a few months later. SSD soon named the new program the Space Experiments Support Program (SESP) and, in September 1965, convened the first meeting of representatives from various government agencies to select experiments for available launches. On 12 March 1968, the Air Staff announced that SESP would be responsible for providing all flight opportunities for research and technology experiments sponsored by government agencies.[57] The program was renamed the Space Test Program (STP) in July 1971 to better describe the broader mission it was beginning to perform.

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[57] SESP had formerly flown only development and engineering experiments, and the Air Force’s Office of Aerospace Research had supported scientific and research experiments. SESP now would be responsible for all of those experiments.

The first SESP mission (P67-1[58]) was launched on 29 June 1967 using a Thor Burner II launch vehicle. It consisted of two separate satellites carrying geodesy and aurora experiments for the Army and Navy. By the middle of the year 2003, STP had flown 168 missions carrying 435 experiments. Many of those missions tested concepts and technology for later operational military satellite systems. In fact, from the early 1970s to the early 2000s, every operational satellite system for DOD flew preliminary experiments through SESP or STP.

We can mention here only a few of the program's best-known missions. The Navigation Technology Satellites NTS-1 and NTS-2 (STP missions P73-3 and P76-4) tested technology—and, in the case of NTS-2, served as a prototype—for satellites of the Global Positioning System. Lincoln Experimental Satellites LES-6 and LES-8/9 (P67-2 and P74-1) demonstrated technology for tactical satellite communications. SOLWIND (P78-1) collected images of the solar corona and finally served as a target for the Air-launched ASAT in 1985. Spacecraft Charging at High Altitudes (SCATHA, P78-2) collected data about the buildup of electrical charges on spacecraft. The Combined Release and Radiation Effects Satellite (CRRES, STP mission P86-1) tested the effects of radiation on electronic components. The Cryogenic Infrared Radiance Instrument for Shuttle (CIRRIS-1A), also known as AFP-675, conducted experiments from the space shuttle (STS-39) dealing with infrared background and detection.[59]

Two of the more recent successes managed and flown by STP were the Advanced Research and Global Observation Satellite (ARGOS, STP mission P91-1) and Coriolis (STP mission P98-2). ARGOS carried nine experiments in a sun-synchronous orbit. It returned data from tests dealing with ionospheric weather, electric propulsion, physics of gas ionization, plume detection, and distribution of orbital debris. ARGOS was the largest, heaviest, most complex, and most costly STP mission to date. Coriolis was managed, launched, and operated by STP. It hosted experimental sensors that provided data about earth and space environments. STP's mission of flying as many experiments as possible—often by having more than one payload share its available spacecraft—sometimes created engineering challenges and ingenious solutions. In the case of Coriolis, for example, one of its sensors (WindSat) had to spin at 31 rpm, while the other (the Solar Mass Ejection Imager) had to lock onto the sun without moving.

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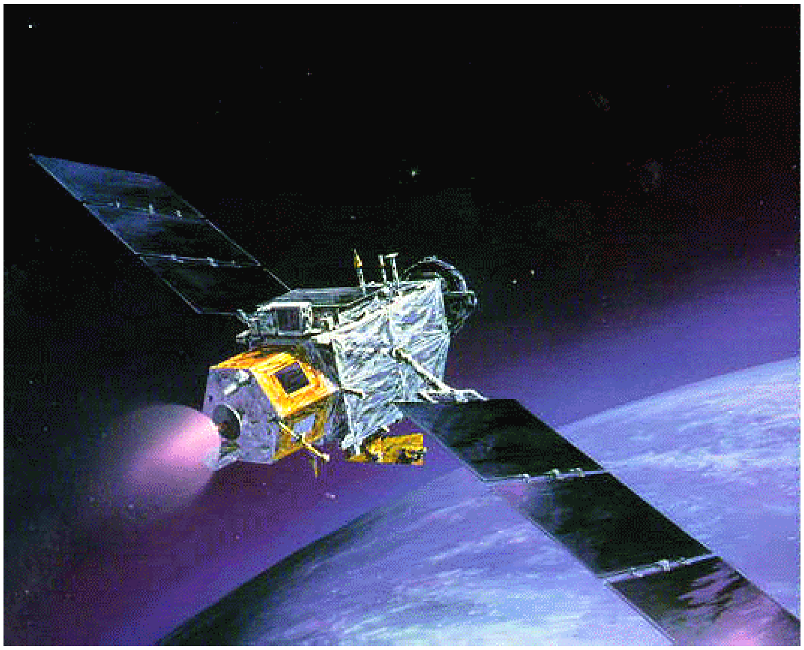
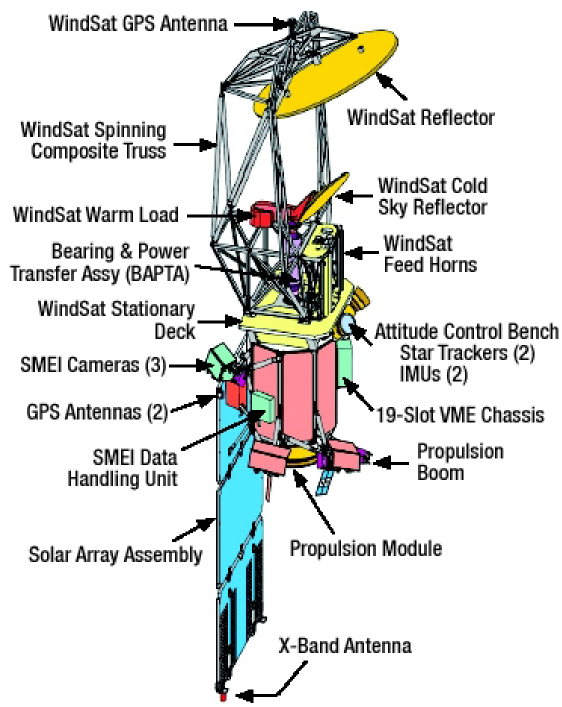
[58] The mission designations used by SESP and STP indicated by their first letters whether the experiments were the primary (P) or secondary (S) payloads for that launch. Later, when STP manifested experiments on the space shuttle, it designated them with the number that NASA assigned to the shuttle mission—for example, STS-83. The designations also showed the year (P**67**-1) and the sequence (P67-**1**) in which the experiments were first manifested for launch. Each experiment within the mission was designated by a name or acronym: for example, the Army experiment on P67-1 was SECOR (Sequential Collation of Range), and the Navy experiment was Aurora I.

[59] The launch dates for the STP missions listed in this paragraph are: P73-3, 14 July 1974; P76-4, 23 June 1977; P67-2, 26 September 1968; P74-1, 15 March 1976; P78-1, 24 February 1979; P-78-2, 30 January 1979; P86-1, 25 July 1990; STS-39, 28 April 1991; P98-2, 6 January 2003.



Left: An artist's concept of the Advanced Research and Global Observation Satellite (ARGOS, STP mission P91-1) in orbit. It carried two technology demonstrations and seven high-priority experiments related to ionospheric studies, electrical systems, and electric propulsion. The experiments were provided by research agencies within the Navy, Army, and Air Force. ARGOS was launched successfully using a Delta II booster on 23 February 1999.

Right: A diagram of the Coriolis satellite shows the major components of its two primary experiments. One was the Naval Research Laboratory's WindSat, which measured wind speed and direction at the surface of the ocean using microwave emissions. It was designed to reduce developmental risks for a new sensor for the NPOESS meteorological satellites (page 42). The other was the Air Force Research Laboratory's Solar Mass Ejection Imager (SMEI), which used three cameras to monitor the propagation of the sun's coronal mass ejections through space, thus warning several days in advance of geomagnetic storms which could disrupt satellite communications and navigation. Coriolis was launched successfully using a Titan II booster on 6 January 2003.



STP performed its mission of providing spaceflight opportunities for experimental payloads in other ways as well. For example, it led in the development of standardized racks, containers, interfaces, and platforms for experiments to be flown as secondary payloads on the space shuttle, Evolved Expendable Launch Vehicles (EELVs), and the International Space Station.[60] STP also put the first internal and external research and development experiments on the International Space Station.[61]

[60] Those standardized devices included the SPARTAN 401 platform deployed by the space shuttle, the Shuttle Hitchhiker Experiment Launcher System (SHELS), the Bridge Launcher System (BLS) pallet for the space shuttle, the EELV Secondary Payload Adapter (ESPA), the Canister for All Payload Ejections (CAPE), and the Window Observation Research Facility (WORF).

[61] The first internal experiment on the International Space Station was the Middeck Active Control Experiment (MACE II), and the first external experiment was the Materials on International Space Station Experiment (MISSE).