AIR FORCE SPACE COMMAND

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HIGH FRONTIER

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SILVER ANNIVERSARY

INSIDE:

Space: The Ultimate High Ground Creating Strategic and Tactical Conditions for Victory

Sharpening the Spear: 25 Years of Serving the Warfighter

ICBMs Past, Present, Future and Air Force Space Command's Critical Role

Headquarters
Air Force
Space Command
Peterson Air Force Base, Colorado

Commander
General Kevin P. Chilton

Director of Public Affairs
Col Les Kodlick

Creative Editor
Ms. Nadine Sage

High Frontier Staff

Lt Col Brenda Armstrong
Dr. Corvin Connolly
Dr. Rick Sturdevant
Maj Troy Endicott
Mr. Masao Doi
Capt Catie Hague
MSgt Jennifer Thibault

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AFSPC/PA
150 Vandenberg St. Ste 1105
Peterson AFB, CO 80914
Telephone: (719) 554-3731
Fax: (719) 554-6013

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Cover: Air Force Space Command 25th Anniversary Patch, background image shows details of the dwarfs in the Coma Cluster from NASA's Spitzer Space Telescope.
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The Journal for Space & Missile Professionals

August 2007 Volume 3, Number 4

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Introduction

General Kevin P. Chilton
Commander, Air Force Space Command

"The establishment of Space Command is a crucial milestone in the evolution of military space operations. Space is a place—like land, sea, and air—a theater of operations. And it was just a matter of time until space was treated as such."

~ General James V. Hartinger, 1 September 1982

This year, we celebrate two significant milestones in Air Force history—the 60th anniversary of the Air Force as a separate service, and the 25th birthday of Air Force Space Command (AFSPC). The men and women, past and present, who have made this Command a relevant provider of combat effects for all mediums and levels of warfare should be proud of their accomplishments. As we engage in global combat operations, we see everyday how our space and missile forces play a significant role in support of land, sea, and air combat operations. Space effects are integrated on tactical battlefields, within operational command and control centers, and for strategic homeland defense. Every day, AFSPC is delivering on its mission statement, ***"To deliver trained and ready Airmen with unrivaled space capabilities to defend America."***

This special edition of *High Frontier* captures the essence of our proud heritage of delivering first-class space professionals and superlative space power while we prepare for future challenges. It is an honor to kick-off this volume with a letter from the Chairman of the Joint Chiefs of Staff, General Peter Pace, USMC, saluting the professionals of AFSPC for 25 years of committed service to our nation. The journal continues with an all-star lineup of distinguished senior leaders who are building on a foundation of space excellence and are skillfully guiding us into the future. The Honorable Michael Wynne, secretary of the Air Force, affirms that space impacts Americans and warfighters each day and he describes how the Air Force pushes the technological envelope to ensure our dominance in air, space, and cyberspace. Our Air Force Chief of Staff, General T. Michael Moseley, reminds us that dominating the 'high frontier' is inextricably linked to our national security and is tightly woven into the fabric of our Air Force priorities. Dr. Michael Griffin, NASA's administrator, illustrates even with distinct peacetime and wartime missions, NASA and AFSPC have intersecting interests and our mutual partnership continues to garner tangible successes.

In this issue, we feature a special 25th anniversary segment that highlights our rich history and links it to the challenges and promises of the future. As a decisive leader during Operation Desert Storm and former AFSPC Commander, General Chuck Horner, USAF, retired, describes how space operations had morphed from Cold War missions to support 'the first space war,' and are forever impacting all levels of modern military operations. Three of AFSPC's top leaders, Lt Gen Michael Hamel, Maj Gen William Shelton, and Maj Gen Thomas Deppe, salute the efforts our past leaders have taken to build the world's pre-eminent space and missile force and provide insight on securing a successful future. Recognizing that our culture is defined by our history, Colonels Kevin McLaughlin and Chris Crawford provide a retrospective look at our doctrine and policies during key timeframes in our past and how they have shaped who we are as a space organization today. Finally, Dr. Rick Sturdevant chronicles the fine nuances of AFSPC's history and highlights the colorful leaders who had the conviction to develop this thriving Command.

As we look back to what has made AFSPC successful, we acknowledge strong partnerships with our industry counterparts and recognize how their innovation has fueled some of our greatest achievements. Mr. Wes Bush, president and chief operating officer at Northrop Grumman, and Ms. Joanne Maguire, executive vice president at Lockheed Martin Space Systems, affirm those historical partnerships and their commitment to maintaining successful momentum.

In our "Warfighter Focus" section, Dr. Michael Stumborg hypothesizes that successful military transformation for all mediums of warfare is buttressed by lessons learned from history, science, and business. In a more focused topic area, Lt Col Andrew Kovich educates the reader on intercontinental ballistic missile strike planning processes and links them to other proven military planning methods. For a space professional update, bright educators from the US Air Force Academy Department of Astronautics outline how the Air Force Academy is arming the next generation of space professionals and leaders with the knowledge requisite to meet our future challenges in space.

Finally in this installment, we are proud to feature the winners of this year's inaugural General Bernard A. Schriever Memorial Essay Contest. 1Lt Brent Ziarnick, Lt Col Scott Maethner, and 1Lt Justin Smith represent some of our best and brightest in AFSPC, and their insightful articles are testaments to how space professionals are thinking hard about the medium in which we operate.

Our mission success throughout our 25 years is due to the talents and achievements of people determined to leave an indelible mark on the space frontier. Articles in this special-edition journal expertly capture our proud history and provide a catalyst for thought on maintaining our dominance in space. I hope you enjoy it.

General Kevin P. Chilton (BS, Engineering Science, USAFA; MS, Mechanical Engineering, Columbia University) is commander, Air Force Space Command, Peterson AFB, Colorado. He is responsible for the development, acquisition and operation of the Air Force's space and missile systems. The general oversees a global network of satellite command and control, communications, missile warning and launch facilities, and ensures the combat readiness of America's intercontinental ballistic missile force. He leads more than 39,700 space professionals who provide combat forces and capabilities to North American Aerospace Defense Command and US Strategic Command.

General Chilton flew operational assignments in the RF-4C and F-15 and is a graduate of the US Air Force Test Pilot School. He conducted weapons testing in various models of the F-4 and F-15 prior to joining the National Aeronautics and Space Administration in 1987. General Chilton is a command-rated astronaut and test pilot with more than 5,000 flying hours. He has flown on three space shuttle missions and served as the deputy program manager for Operations for the International Space Station.

The general has served on the Air Force Space Command Staff, the Joint Staff, the Air Staff, and commanded the 9th Reconnaissance Wing. Prior to assuming his current position, he was commander, 8th Air Force and joint functional component commander for Space and Global Strike.

Among his many awards, General Chilton has been awarded the Distinguished Service Medal, the Distinguished Flying Cross, and the NASA Exceptional Service Medal. At his promotion ceremony 26 June 2006, he became the first astronaut to reach the rank of four-star general.

CHAIRMAN OF THE JOINT CHIEFS OF STAFF
WASHINGTON, D.C. 20318-9999

A SALUTE TO THE AIR FORCE SPACE COMMAND

Congratulations to Air Force Space Command on its 25th anniversary. From satellite operations to space surveillance to nuclear deterrence, Air Force Space Command delivers a broad range of essential capabilities that support and protect our Nation's interests around the globe.

The military and civilian professionals within Air Force Space Command continue to meet the dynamic challenges of securing and expanding America's global space leadership. Your contributions are critical to the success of the joint warfighter.

The Joint Chiefs of Staff join me in thanking the men and women of Air Force Space Command for 25 years of dedicated service and commitment to our Nation's security. You are a point of pride for the Armed Forces, and we join you in celebrating this milestone. Best wishes for continued success.

Respectfully,

Peter Pace

PETER PACE
General, United States Marine Corps
Chairman
of the Joint Chiefs of Staff

Senior Leader Perspective

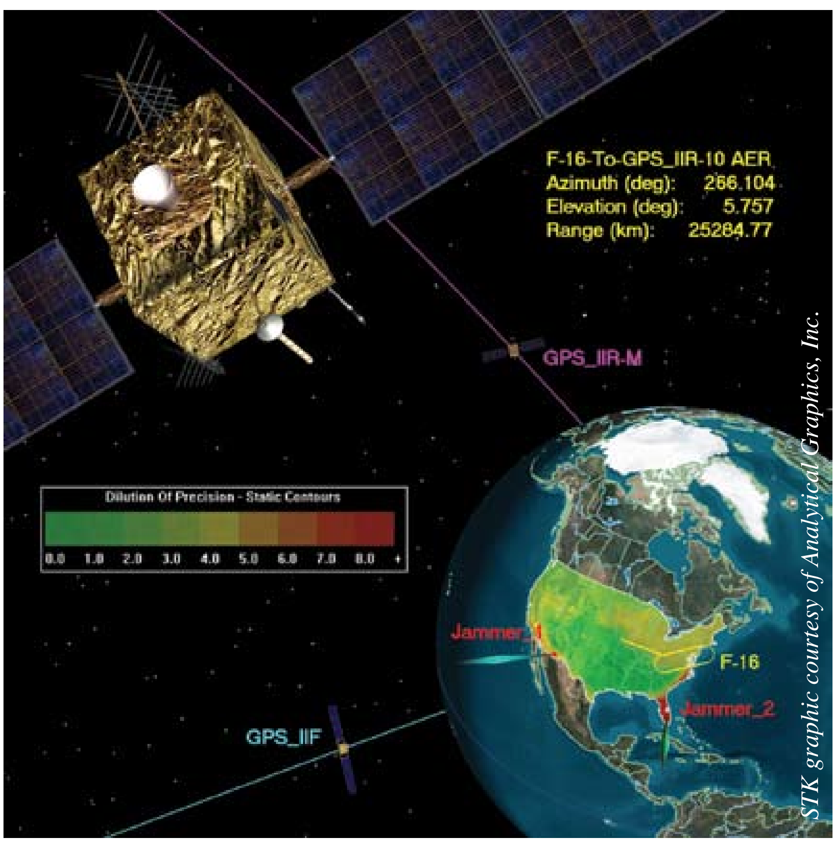
Space: The Ultimate High Ground Creating Strategic and Tactical Conditions for Victory

The Honorable Michael W. Wynne
Secretary of the Air Force

America's domination of the space domain provides an unrivaled advantage for our nation and remains critical to creating the strategic and tactical conditions for victory. As our Air Force celebrates its 60th anniversary and Air Force Space Command (AFSPC) celebrates its 25th anniversary, I would like to highlight how, through your systems, people and processes, the Air Force is postured to meet the challenges of the 21st century with unrivaled space capabilities.

Foremost, we must realize our access to and dominance in the domain of space is not a given. On 11 January 2007, China destroyed one of its weather satellites, proving that space is no longer a sanctuary. In that one single act, China demonstrated the vulnerability of our nation's space assets. We can no longer think the same way about how wars will be fought in the future or how the Armed Forces, especially the Air Force, must be organized, trained, and equipped.

It is the Air Force's mission to provide the nation with sovereign options. These options leverage our control of air, space, and cyberspace and present the president with a spectrum of choices to deal with problems ranging from natural disasters, defense of the homeland, to fighting across the entire spectrum of warfare. Yet today's challenges are not the same as when AFSPC was established 25 years ago. Thanks to the innovation, leadership, and dedication of the Airmen of AFPSC we remain on point in delivering key space effects—providing unmatched speed, lethality, precision, awareness, and connectivity.



GPS–space assets such as the GPS satellite system provide the Armed Forces with a strategic high ground during military operations.

With space, the Armed Forces are now able to deliver new levels of precision strike. In World War II, it took 1,500 B-17s dropping 9,000 bombs to destroy a given target. Today, one B-2 can strike and destroy 80 different targets on a single mission using weapons guided by space-based USAF global positioning system (GPS) signals. Space assets may be thousands of miles from the fight, but their effects are apparent from the tactical to the strategic level of warfare. Our space-based intelligence, surveillance, and reconnaissance and satellites remain central to precision navigation and joint targeting. Weather and GPS satellites are crucial nodes in the target selection and weaponeering process. Satellite communication systems pass vital command and control orders linking fielded forces, intelligence professionals, and decision-makers making global operations a reality.

Space systems are a vital part of our homeland defense. For example, imagery from the Defense Meteorological Satellite Program is used in tracking hurricanes and storm development for national agencies. AFSPC Airmen also stand guard 24/7 operating an integrated worldwide early warning network guarding against missile threats against the nation. Through a complex system of radars and satellites AFSPC Airmen provide continuous coverage to detect and characterize strategic and theater missile launches, identifying accurate launch points and impact point predictions. Lastly, deployed across the vast missile fields of the northern tier and heartland of America, Airmen stand poised and ready while guarding, maintaining, and operating our nation's nuclear strategic backstop—always ready to respond, within seconds of presidential orders.

These space systems may seem transparent, but they impact Americans and warfighters each day. To bring you these high-tech systems, the Air Force continually pushes

The strides in space integration over the last 25 years are astounding and continue to be the envy of militaries around the globe. And we are setting the bar higher as we adapt to new challenges, sustain our capabilities, infuse new technologies into our future systems, and defend our space assets.

the technology envelope, finding new ways to ensure our dominance in air, space, and cyberspace. Achieving this dominance requires us to be innovative—discovering new technologies; finding new applications for existing technologies; and making it our business to stay one technological step ahead.

To win this technological fight, we must employ and operate systems built on proven technology to dominate our respective domains. We have the best acquisition professionals in the world and our nation's security begins with their excellence. AFPSC acquisition experts continue to hone their partnerships with industry and user communities to deliver decisive capabilities, on cost and on schedule. Our current operational space systems have served us well over the last 25 years, but it is imperative we recapitalize, modernize, and transform our capabilities to maintain the edge we have earned in the space domain.

To maintain this edge we are focusing efforts to provide persistent and accurate space situation awareness in the defense of our space capabilities. To do this we need trained technical personnel in the areas of acquisitions and operations. In the uncertain world in which we live, our 10,000-plus space professionals are training for the contingencies of today and tomorrow. AFPSC took the lead in space training and education within national security space, and continues to develop, maintain, and sustain space power education within the Air Force and across the national security space community.

The strides in space integration over the last 25 years are astounding and continue to be the envy of militaries around the globe. And we are setting the bar higher as we adapt to new challenges, sustain our capabilities, infuse new technologies into our future systems, and defend our space assets. We can only do this with the highly skilled space professionals and acquisition workforce we have in the Air Force.

As we reflect upon the last 25 years, let us take counsel of our experience while minding the future. I challenge you to remain focused on preserving the ultimate high ground and fully leveraging all its capabilities and advantages. Let us meet the imperatives of today, critical to securing our future. And let us remain committed to dominating the *High Frontiers* of space and setting the conditions for strategic and tactical victory so vital to our nation's security.

The Honorable Michael W. Wynne (BS, General Engineering, USMA; MS, Electrical Engineering, AFIT; MBA, Business, University of Colorado) is the secretary of the Air Force, Washington, DC. He is the 21st secretary and was confirmed on 3 November 2005. He is responsible for the affairs of the Department of the Air Force, including the organizing, training, equipping, and providing for the welfare of its nearly 370,000 men and women on active duty, 180,000 members of the Air National Guard and the Air Force Reserve, 160,000 civilians, and their families. With an annual budget of approximately $110 billion, he ensures the Air Force can meet its current and future operational requirements.

Prior to assuming his current position, Mr. Wynne served as principal deputy under secretary of defense for acquisition, technology and logistics, and under secretary of defense for acquisition, technology and logistics. In these positions he was the principal adviser to the secretary and deputy secretary of defense for all matters relating to acquisition, research and development, and logistics management.

In 1999 Mr. Wynne retired from his position as senior vice president from General Dynamics, where his role was in international development and strategy. He had rejoined the company at the invitation of the chairman to strengthen international activities. In between working with General Dynamics, he spent three years with Lockheed Martin, having sold the General Dynamics' Space Systems Division to then Martin Marietta. He successfully integrated the division into the Astronautics Company and became the general manager of the Space Launch Systems segment, combining the Titan with the Atlas Launch vehicles. Mr. Wynne spent a total of 23 years with General Dynamics in various senior positions with the Aircraft (F-16s) and Main Battle Tanks (M1A2) Divisions, and served on the corporate staff prior to becoming the president of space systems, including launch vehicles (Atlas and Centaur), and a corporate vice president.

Dominating the High Frontier: The Cornerstone of Global Vigilance, Global Reach, and Global Power

General T. Michael Moseley
18th Chief of Staff, United States Air Force

At the height of the Cold War, with no end or victory in sight, the Soviet Union began pursuing an anti-satellite (ASAT) capability that threatened America's increasing reliance on space capabilities. This precarious situation caught the attention of 10th Chief of Staff of the Air Force, General Lew Allen, Jr., a leader many thought was also the most gifted scientist in the Air Force. General Allen felt so strongly about the imperative to operationalize space that he pushed hard to create Air Force Space Command (AFSPC), which stood up on 1 September 1982. General Allen tasked AFSPC to carry the banner of space operations and acquisition for the Air Force and the nation—a banner it proudly carries to this day, 25 years later.

As we reflect on our Air Force's space heritage and look to its boundless horizon, we are reminded that AFSPC is the command that never rests, providing persistent communications and navigation, a ready striking force, and unmatched access to space and control of space assets. We are also reminded that the command's history and future remain inextricably linked to our nation's security. In fact, the success of today's military hinges on maintaining American dominance in space, a domain that is becoming more heavily populated and increasingly threatening, as the character of warfare constantly changes.

Because we have to be prepared to operate in strategic environments where disagreements may spark violence across the spectrum of conflict, the Air Force must be equally adept at defending our nation, its interests, and ideals against high-end conventional forces, asymmetric threats, and irregular forces. Ensuring that capability today and projecting American power with precision around the globe demands we protect the space dominance that gives the Air Force its global vigilance, global reach, and global power. Given its importance to us, it is no surprise that our space dominance is tightly woven into the fabric of our top three Air Force priorities: waging and winning the Global War on Terrorism (GWOT) while ensuring we are ready for future conflicts; developing our Airmen and taking care of them and their families; and recapitalizing and modernizing our aging air and space inventories.

After all, every single day America's joint team uses space effects *tactically* and *operationally* in its conduct of the GWOT. For example, in Operations Iraqi Freedom and Enduring Freedom we use the information from space-based intelligence, surveillance, and reconnaissance systems; we communicate real-time to the other side of the world through Military Satellite Communications; and our ground, maritime, and air components navigate and strike targets with unprecedented accuracy using Air Force-owned and -operated position, navigation, and timing systems. Satellite systems such as MILSTAR, the global positioning system and Defense Meteorological Satellite Program lift the fog of war for our nation's Soldiers, Sailors, Marines, Coast Guardsmen, and Airmen, making them dramatically more combat effective than ever before.

At the *strategic* level AFSPC Airmen cover our troops and nation with the protective canopy of space-based early warning from the Defense Support Program and Space-Based Infrared System, in conjunction with our numerous ground-based radars. AFSPC Airmen also ensure strategic deterrence by operating, maintaining, and safeguarding our land-based ICBM inventory, spread across the nation's heartland. Knowing that our Airmen are on constant alert and can react on a moment's notice gives other nations and non-state actors pause before considering using weapons of mass destruction. Finally, AFSPC ensures our nation's access to space with its launch expertise, having now achieved more than 50 successful launches in a row. At *all* levels of warfare, and across the spectrum of conflict, AFSPC has ensured dominance from the high frontier.

However, that dominance in space did not come about overnight and is not guaranteed. It took tremendous vision and courage of conviction from pioneering Airmen like General Allen, General Bernard A. Schriever, and General James V. Hartinger. It took a commitment from the nation to resource our space enterprise properly. More importantly, it took decades of creativity, innovation, and hard work, as payloads, satellites, radars, and rockets evolved from technical demonstrations to operational space systems that bring integrated cutting-edge capabilities to joint warfighters.

Space is the domain of Airmen just as much as the air, and we have to ensure that all Airmen understand and appreciate the critical capabilities space brings to the fight. We must continue to foster a culture in the Air Force where space capabilities are understood from our newest Airmen to the highest levels of command. From Basic Military Training to Senior Developmental Education, AFSPC ensures pertinent, updated information is part of the curriculum so that new accessions are exposed to space capabilities from the start of their careers and understand how those capabilities are integrated into our warfighting ability.

Airmen designated as space professionals receive specialized education in space through courses like ones offered at the Air Force's National Security Space Institute (NSSI). The NSSI provides the opportunity for leaders from the Air Force, joint services, coalition partner nations, and government agencies to learn what AFSPC brings to the fight. This one-of-a-kind space power education course prepares warfighters for joint military operations by providing world-class instruction on space system technologies, capabilities, operational concepts, acquisition, and tactics. The NSSI also prepares many of our best and brightest officers for the USAF Weapons School.

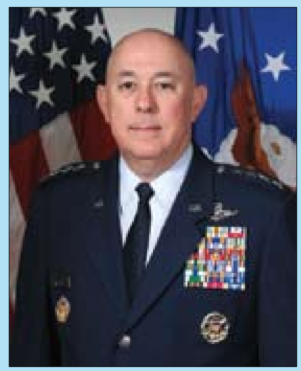
It's easy to see why this development is important. Space weapons officers and other deployed space professionals continue to integrate space capabilities into our Combined Air Operations Centers (CAOCs) at Al Udeid in Qatar and around the world. The growing presence of space expertise in combat theaters cultivates the integration of space into the planning and execution decision-making process, ensuring our warfighting combatant commanders have full access to space effects. We have also taken integration a step further by deploying senior space leaders to CAOCs as directors of Space Forces (DIRSPACEFOR), a practice that ensures space unity of command within a theater's effort and institutionalizes the concept of a single space voice for each combatant commander. In this way and others, AFSPC's new, more deliberate process of developing space professionals is already making an impact across the Department of Defense.

But with increased understanding and use of space effects, there is also the urgent need to replace our aging space inventory and further develop our space situational awareness. Many of the systems operating today in the vacuum of space were built in the 1960s and need to be replaced, in the same way we must re-capitalize our inventory of aging aircraft. Many of our on-orbit space systems have reached or have exceeded their design life, and they are now more vulnerable to emerging threats. The operating environment of space is no longer a safe haven, as the successful Chinese ASAT test in January this year unambiguously demonstrated. That strategically dislocating event was a rude awakening to many, and well it should be. But while we cannot forget it, we cannot let it dominate our thinking, either. There are other, perhaps more insidious threats to our space dominance. For example, technology this century is increasing at such a fast pace that it is allowing other nations to more heavily populate space with payloads that are in some cases more advanced than our own, reducing our technological advantage. And there are some Americans who have grown so accustomed to American space dominance that they do not appreciate the time, effort, vision and investment we need to spend as a nation to maintain this vital asymmetric advantage.

As stewards of space for our nation, the Air Force must lead the way in meeting these challenges, defending our satellites, and securing our space dominance. We must invest in space situational awareness to ensure our current and future systems are protected from enemy interference and attack. Over the next 10 years, we have to recapitalize and modernize all our on-orbit space assets if we intend to have space dominance for the next 25 years and beyond, a massive undertaking we have already begun but which must continue unabated. And we need our space professionals to continue expanding space integration into warfighting if we are to more fully realize General Allen's vision for what space can do.

As we celebrate our Air Force's 60th anniversary and Air Force Space Command's 25th anniversary, it is important to reflect on how far AFSPC has come, and how incredibly important the command has become to the Air Force, the joint team, and the nation. The Airmen of AFSPC enjoy leadership, innovation, and combat focus that are the envy of every space-faring nation, qualities that chart a sure trajectory for AFSPC's future successes. While the command's expertise in space makes it unique, it is the global projection, seamless integration, and innovative application of those capabilities with air power that make AFSPC uniquely Air Force. Thanks to AFSPC, we remain the world's pre-eminent air, space, and cyber force, and we will depend on the vision and energy of its space professionals to maintain the all-important asymmetric advantages we give our country.

(Editor's notes: General Allen is one of AFSPC's Space and Missile Pioneers for 2007.)



General T. Michael Moseley (BA, Political Science, Texas A&M; MA, Political Science, Texas A&M) is chief of staff of the US Air Force, Washington, DC. As chief, he serves as the senior uniformed Air Force officer responsible for the organization, training, and equipage of more than 710,000 active-duty, Guard, Reserve and civilian forces serving in the United States and overseas. As a member of the Joint Chiefs of Staff, the general and other service chiefs function as military advisers to the Secretary of Defense, National Security Council and the president.

General Moseley has commanded the F-15 Division of the USAF Fighter Weapons School at Nellis AFB, Nevada, the 33rd Operations Group at Eglin AFB, Florida, and the 57th Wing, the Air Force's largest, most diverse flying wing, also at Nellis. The general has served as the combat director of operations for Joint Task Force-Southwest Asia. General Moseley also commanded 9th Air Force and US Central Command Air Forces while serving as Combined Forces Air Component Commander for operations Southern Watch, Enduring Freedom, and Iraqi Freedom. General Moseley's staff assignments include serving in Washington, DC, as director for legislative liaison for the secretary of the Air Force; deputy director for Politico-Military Affairs for Asia/Pacific and Middle East, the Joint Chiefs of Staff; chief of the Air Force General Officer Matters Office; chief of staff of the Air Force Chair and Professor of Joint and Combined Warfare at the National War College; and chief of the Tactical Fighter Branch, Tactical Forces Division, Directorate of Plans, Headquarters US Air Force.

Among his many awards, General Moseley has been awarded the Defense Distinguished Service Medal, the Distinguished Service Medal, and the Defense Superior Service Medal. In 2003, he was presented with the H. H. Arnold Award, the Air Force Association's highest honor to a military member in the field of National Security, and in 2005 he was inducted into the Texas A&M Corps of Cadets Hall of Honor.

Senior Leader Perspective

Civilian and Military Cooperation in Space

Dr. Michael D. Griffin
Administrator, NASA

On this, the 25th anniversary of the Air Force Space Command (AFSPC), we have the opportunity to acknowledge our nation's growing reliance on space capabilities to ensure the safety and security of its citizens. I salute former NASA astronaut General Kevin P. Chilton, commander of AFSPC, and his team for their outstanding work in executing the command's mission of maintaining US pre-eminence "in the application of space power for national security and joint warfare."

From NASA's perspective, it is useful to note that, concurrent with expanded US military use of space in the past quarter century, our nation's civil space program has implemented the space shuttle program to provide routine human access to space, leading to the permanent presence of crew members on board the International Space Station (ISS). Importantly, throughout their service lives, the unique capabilities of the shuttle and ISS have been used by our colleagues in the defense community for experiments to develop innovative new technologies.

NASA is now embarking on an important new effort to extend our reach in space. Following the policy direction given to us by the president in 2004 and by two successive Congresses to further "US scientific, security, and economic interests" through a vigorous, focused space exploration program, NASA is now working to expand the scope of human civilization throughout the inner solar system. By 2024, in cooperation with international partners, we will have established an expeditionary base on the lunar surface, which will be used to advance scientific, commercial and technological progress.

Our respective institutions' distinct, but complementary, missions have their origin in wise policy decisions made by our national leadership at the dawn of the space age, some 50 years ago. At that time, the US decided to pursue separate civil and military space programs, the first having the mandate to conduct peaceful exploration and research, and the second to use space as an extension and enhancer of our land, sea, and air force projection. This separation of roles brings to mind the Great Seal of the United States. In the seal a bald eagle is clutching in its right talon an olive branch, representing peace, and holding 13 arrows in its left, representing war. This symbolism amply applies to our space activities, with America's commitment via NASA to leadership in the peaceful exploration of space on one hand, along with our nation's need to leverage space to support our warfighters on the other.

While NASA and AFSPC have distinct missions, our two organizations also have common interests that bind us together in many productive ways. To accomplish our goals, NASA works hand-in-hand with our military space colleagues to mutually enhance launch capabilities, space technologies, and aerospace workforce skills. We rely on AFSPC through its space surveillance radars to provide vital information on the location of space debris that could pose a risk to our missions. We also count on talented Air Force officers such as General Chilton, who as an astronaut flew the maiden voyage of Space Shuttle *Endeavour*; the Space Radar Laboratory mission on another *Endeavor* flight; and commanded STS-76, the third docking mission to the Russian space station *Mir*, to contribute to the work of our astronaut corps. More than 20 active and reserve duty Air Force personnel are current astronauts.

Space Shuttle Endeavour.

One specific mechanism for NASA-AFSPC cooperation is the Space Partnership Council, formed nine years ago between NASA and AFSPC, with the later additions of the National Reconnaissance Office, US Strategic Command, Defense Research and Engineering, the Department of Defense Executive Agent for Space, and the Central Intelligence Agency Directorate of Science and Technology. The Partnership Council, which meets at least biannually, provides a tremendous model of different government agencies finding ways to help each other serve the public interest more effectively and efficiently.

"Besides the direct military importance of space, our prestige as world leaders might well dictate that we undertake lunar expeditions and even interplanetary flight when the appropriate technological advances have been made and the time is ripe."

~ General Bernard A. Schriever

One of the Council's initiatives is to improve our space communications technological capabilities and capacity. In pursuit of this objective, the Partnership Council has fostered the merger of future communications capabilities in support of our space satellite operations and implementation of those capabilities in a system that will serve other parties.

In the area of space access, the Council is supporting the development of an enhanced RS-68 rocket engine. While powering the nation's evolved expendable launch vehicle program today, an enhanced and improved engine will also thrust into space the NASA Ares V rocket, a key element in enabling NASA to send human missions to the moon and beyond. Additionally, as NASA adds advancements to the nation's East Coast launch capabilities to support our future exploration launches, we are working directly with AFSPC to partner in mutually beneficial range modernization.

The Partnership Council also has a common interest in NASA's development in the Earth and space observing systems that will help provide scientists a solid foundation for understanding the complex Earth and Sun climate systems. In this effort, we are demonstrating a number of unique uses for imagers, radars, and lasers needed to probe the Earth and Sun systems, structure, and dynamics. In addition to their scientific promise, the national security community has identified potential uses for these technologies. As a consequence, we are working through the Partnership Council to help our colleagues better understand and utilize these emerging technologies.

Another productive NASA partnership with AFSPC is in the area of space navigation. To support missions in low-Earth orbit and beyond NASA has developed a long-term space navigation architecture. This capability is dependent on the AFSPC-operated global positioning system (GPS). The precision time signals of GPS also will be crucial to synchronizing networks in the lunar environment and elsewhere in the solar system. Additionally, NASA has developed a new, highly effective GPS-based search and rescue capability, known as the Distress Alert Satellite System or DASS, and is working with AFSPC to include this capability on future GPS satellites.

The strong bonds that link NASA and the AFSPC today bring to mind the visionary spirit of Air Force General Bernard A. Schriever, who 50 years ago spoke about America's need to lead the way into the space environment for both civil and military purposes. In his 19 February 1957 remarks to the inaugural Air Force Office of Scientific Research Astronautics Symposium, General Schriever said, "Besides the direct military importance of space, our prestige as world leaders might well dictate that we undertake lunar expeditions and even interplanetary flight when the appropriate technological advances have been made and the time is ripe."

Today, the time is ripe for our next great leaps in space, due in large part to the continued strong cooperation between our respective institutions. It is my hope that 25 years from now, when the AFSPC celebrates its 50^{th} anniversary, your organization will continue to be a strong force guaranteeing peace through strength, thus enabling our country to expand our reach ever outward in the space frontier.

Dr. Michael D. Griffin (BS, Physics, Johns Hopkins University; MS, Aerospace Science, Catholic University of America; PhD, Aerospace Engineering, University of Maryland; MS, Electrical Engineering, University of Southern California; MS, Applied Physics, Johns Hopkins University; MBA, Business Administration, Loyola College; MS, Civil Engineering, George Washington University) was nominated by President George W. Bush and confirmed by the United States Senate, and began his duties as the 11^{th} administrator of the National Aeronautics and Space Administration on 14 April 2005. As administrator, he leads the NASA team and manages its resources to advance the US Vision for Space Exploration.

Prior to being nominated as NASA administrator, Dr. Griffin was serving as Space Department head at Johns Hopkins University's Applied Physics Laboratory in Laurel, Maryland. He was previously president and chief operating officer of In-Q-Tel, Inc., and also served in several positions within Orbital Sciences Corporation, Dulles, Virginia, including chief executive officer of Orbital's Magellan Systems division and general manager of the Space Systems Group.

Earlier in his career, Dr. Griffin served as chief engineer and as associate administrator for Exploration at NASA, and as deputy for technology at the Strategic Defense Initiative Organization. He has been an adjunct professor at the University of Maryland, Johns Hopkins University, and George Washington University, where he taught courses in spacecraft design, applied mathematics, guidance and navigation, compressible flow, computational fluid dynamics, spacecraft attitude control, astrodynamics, and introductory aerospace engineering. He is the lead author of more than two dozen technical papers, as well as the textbook, "Space Vehicle Design."

A registered professional engineer in Maryland and California, Griffin is a member of the National Academy of Engineering and the International Academy of Astronautics, an honorary fellow of the American Institute of Aeronautics and Astronautics (AIAA), a fellow of the American Astronautical Society, and a member of the Institute of Electrical and Electronic Engineers. He is a recipient of the NASA Exceptional Achievement Medal, the AIAA Space Systems Medal, and the Department of Defense Distinguished Public Service Medal, the highest award given to a non-government employee.

He is a certified flight instructor with instrument and multi-engine ratings.

The Legacy of the First Space War

General Charles A. Horner, USAF, retired

In 1992, I assumed command of Air Force Space Command (AFSPC) and brought with me a first hand awareness of the importance space had played in the then recent conflict to liberate occupied Kuwait. As a result Desert Storm has been cited as the first space war. During the 1960s and 1970s, space had played an important role in supporting "strategic" operations with missile warning and collection of intelligence over denied airspace. In the 1980s, space contributions expanded in the areas of communication and precision navigation. On the eve of Desert Shield in August 1990, members of all military services had some appreciation of how critical space-based systems had become to air, land and sea combat operations. In July of that year we in Central Command held a war game exercise that examined possible combat against Country Orange which had invaded its southern neighbors, Kuwait and Saudi Arabia. Part of that exercise was to define how space systems could aid our operations and how we could deny Country Orange access to space capabilities and products.

Since their inception, America's space agencies were focused on the Cold War and developing the technology needed to orbit and exploit capabilities that would support deterrence and nuclear war fighting strategies. The stakes in the game were high and these capabilities and their products were highly classified. The Soviet Union dominated our interest and the Single Integrated Operations Plan was the primary customers' war plan. The few products that were of value to the "conventional," "theater," or "tactical" users had to be dumbed down to preclude disclosure of our growing space capabilities. The result was that few of those who planned and executed combat operations in Vietnam, Grenada, and Panama had an appreciation of how to exploit space-based capabilities and products. The fact that space professionals were focused on technology and national/strategic operations coupled with the fact that they were hidden behind what was then called "the green door" likewise made it difficult to integrate space fully into conventional warfare. Change was inevitable and it came with lightening speed.

USAF photo of F-16A, F-15C, F-15E war planes flying over burning oil wells during Desert Storm, 1991.

Goldwater-Nichols, the impending end of the Cold War, the creation of a unified space command and the growing demand for space-based capabilities, services and products created a surge that thrust space into a position of being equal in importance with traditional mediums of warfare. Under Goldwater-Nichols unified commanders owned and operated operational forces not the services. Their commanders reported directly to the secretary of defense not the Joint Chiefs of Staff, its chairman, or any service chief. Theater commanders around the world began to examine their warfighting needs and what role space could play in their operations. As the Soviet Union began to disintegrate, forward-thinking members in the strategic commands and national agencies began to look at how they could adapt their operations to support more fully the regional commanders. United States Space Command brought together members of all military services in one staff with subordinate service components. While this unified effort was dominated by AFSPC, it opened the door for others to appreciate more fully what space had to offer to other combat operations. Air, land, and sea planners also began to examine how they could support space operations although it did not occur to them to frame their thoughts in this manner as each thought of itself as the dominate action requiring that all others support them. Finally, technologies began to expand so that space-based systems could provide highly desirable combat capabilities to various war fighting partners. The global positioning system (GPS) began to provide what has now become a critical service to traditional fighting forces. Last-mile satellite communications often were more valuable than globe-circling bounced signals. The fact that Saddam Hussein had a ballistic missile force meant that the Cold War ballistic missile warning capability had to be adapted to providing warning of real launches against coalition forces and allies in seconds and that unlike the Cold War threat assessments, false alarms were far more preferable than no warning at all. The men and women of AFSPC were thrust into combat as another warrior although they were often armed with a computer key board and cathode ray tube rather than an F-16, rifle, or battleship.

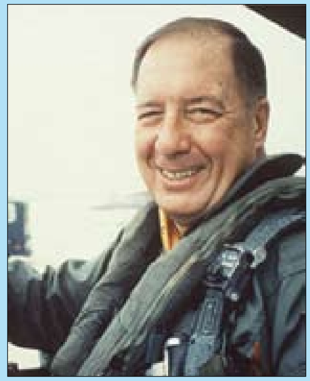
On the flip side of the coin, in Central Command Air Forces we worried how we could keep Iraq from having access to space-based capabilities. Of primary interest was space imagery which could alert the enemy to the coalition's planned secret movement of ground forces that would assault Iraqi right flank. Once Desert Storm started I could guarantee my commanders that the Iraqi air reconnaissance would not be allowed to detect this massive relocation of our forces; now I had to figure out how to deny Saddam Hussein access to space reconnaissance.

Space professionals must acquaint themselves with the air, land, and sea operations so they can define better what goods and services they can contribute, while the non-space forces had better learn how they can support space operations so the whole force becomes more lethal and responsive.

Fortunately, our coalition included British, French, and Italian forces so it was not difficult to shut off access to European Space Agency imagery. Russian imagery was a different matter, but to the best of my knowledge they also complied with our diplomatic requests. We also imposed offensive space control operations by bombing Iraqi and Kuwaiti communication satellite ground stations both to deny information from coming into or out of the country and to make command and control of enemy combat forces more difficult. The subsequent six weeks of war indicate that our offensive space control operations were as successful as our defensive space operations. I doubt if we will be so lucky in the next major conflict. Already we have seen GPS jamming and a kinetic attack demonstration on a dying satellite. As space grows in importance in war so will the efforts to counter space operations, and as the premier space nation the United States will face the greatest threats.

Military services resist change, space technology thrives on it, therefore our doctrine, organization, and practices associated with space warfare have lagged its potential. Now space research and development efforts are aligned with its operations, not a subset of air efforts. A true space leader now commands AFSPC, unlike me who was a pilot that parachuted in due to the requirements of the dual command with North American Aerospace Command, a reason to thank the Rumsfeld Space Commission. Space launch remains a complex but now routine operation. A growing number of space educated and motivated young Americans are available to recruit into our Space Force. Still much remains to be done. We must continue to be vigilant for efforts to deny our access to space capabilities and for adversaries to exploit opportunities space offers them. Our space operations must continue to become more reliable and efficient. Space professionals must acquaint themselves with the air, land, and sea operations so they can define better what goods and services they can contribute, while the non-space forces had better learn how they can support space operations so the whole force becomes more lethal and responsive.

I used to accuse the space warriors of doing their war dance inside their own teepee. It appeared to me that in the earlier times space people were embarrassed that they were different. This attitude ignored the fact that it was okay for a fighter pilot to be different from a machine gunner or submarine crew member. On the twenty-fifth birthday of AFSPC, we are well aware of the fact that space operations and people are different. Of greatest importance is that they are proud of what they do and how they do it because space operations are critical to our national security.



General Charles A. Horner (BA, University of Iowa; MBA, College of William and Mary) retired from the United States Air Force after serving as the commander in chief North American Aerospace Defense Command and the United States Space Command and commander of Air Force Space Command. He was born in Davenport, Iowa and entered the Air Force through the ROTC program at the University of Iowa. During his career he commanded two tactical fighter wings, two air divisions, the Air Defense Weapons Center and 9th Air Force prior to being assigned to Command Unified Space Command/NORAD. As commander of 9th Air Force, he also commanded United States Central Command Air Forces and during Operations Desert Shield and Desert Storm he was in command of all US and allied air assets. He is a command pilot with over 5,500 flying hours in a variety of fighter aircraft. During the Vietnam conflict he flew 111 combat missions in F-105 fighter and F-105F Wild Weasel aircraft.

General Horner is a graduate of the Air Force Squadron Officer School, 1967; Armed Forces Staff College, 1972; Industrial College of the Armed Forces, 1974; and the National War College, 1976. He has been awarded the Defense Distinguished Service Medal, Air Force Distinguished Service Medal with two oak leaf clusters, Silver Star with oak leaf cluster, Legion of Merit, Distinguished Flying Cross, Meritorious Service Medal, Air Medal, Aerial Achievement Medal, Air Force Commendation Medal, and other service and campaign medals. He has been decorated by the sovereign nations of Bahrain, Canada, France Kuwait, Pakistan, Saudi Arabia, and The United Arab Emirates. He was awarded the US News Trophy, 1991; Maxwell A. Kriendler Memorial Award, 1991; Order of the Sword, 1991; History of Aviation Award, 1991; Aviation Achievement Award, 1991; Aviation Week and Space Technology Aerospace Laureate, 1991; National Veteran's Award, 1992, James V. Hartinger Award, 1994; Bernard Schriever Award, 1994; University of Iowa Distinguished Alumni Award, 1994; American Patriot of the Year Award, 1994; and the National Geographic Society, General Thomas D. White Space Trophy, 1996. General Horner has written numerous articles on national security that have been published in newspapers and magazines in the United States, Europe, and South America. He co-authored with Mr. Tom Clancy, the best selling non-fiction novel, *Every Man A Tiger*. He has appeared in numerous national and foreign television programs on current events and the Gulf War and has been retained as a defense analyst by ABC and BBC News. He serves on, the University of West Florida Board of Trustees and the KBS Living Oceans Foundation.

Air Force Space Command: Proud Heritage ... Boundless Future

Lt Gen Michael A. Hamel
Commander, Space and Missile Systems Center
Los Angeles AFB, California

"…We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win…"

~ President John F. Kennedy,
Speech at Rice University, Houston, Texas

The space race officially began some 50 years ago with the orbiting of Sputnik in October 1957, an event that energized a determined US national effort to establish world leadership in space. Seldom in history, have we witnessed the breadth and magnitude of national and international impacts that space has brought to our security, economic, science and national interests. Space capabilities today provide unprecedented global presence, access, precision, speed, and agility, which give unique and asymmetric military advantages to the United States. They have advanced from simple demonstrations of the feasibility of orbiting satellites, to delivering routine and reliable service to all military operations through a broad array of sophisticated space systems. Today, military operations demonstrate on a daily basis the critical role space plays in planning and conducting joint military operations across the spectrum of conflict from peace, to crisis, to war. Employed in virtually every aspect of military planning and operations, space critically enables warfare at all levels from strategic to tactical, and has become integrated into air, land, maritime, and special operations. The distinctive advantages provided by space based assets are utilized across each service, as well as defense and civil agencies, and even with our allies and coalition partners. These capabilities range from the global positioning system satellites, enabling precision timing, navigation and strike; to the communications satellites providing worldwide secure and high bandwidth communication for robust command and control of military forces; to the space based infrared systems providing global surveillance and warning of threats; to space situational awareness assets, protecting our space capabilities. As the principle force provider for these dominant space based capabilities, Air Force Space Command celebrates 25 years of leadership, pioneering spirit and innovation, focused on developing, operating, and employing unrivaled space capabilities for joint warfighting. With a proven record of military space leadership and a proud tradition of achievement and success, the command is postured to lead the United States and shape our future as the premier spacefaring nation in the world.

Figure 1. General Bernard A. Schriever with Secretary of the Air Force Donald Quarles at the Western Development Division in 1956.

Birth of Air Force Space

Air Force space began as a critical element of the national response to the Soviet threat in the early days of the Cold War. Faced with growing evidence of the Soviet Union's development of thermonuclear weapons and ballistic missile technology, the Air Force in 1953 chartered the Strategic Missiles Evaluation "Teapot" Committee to assess the slow pace of America's strategic missile programs. Based on recommendation from the committee, Project Atlas, the only American intercontinental ballistic missile (ICBM) then under development, was reoriented and accelerated. In 1954, the Air Force established the Western Development Division (WDD) to carry out that task, and sent Brig Gen Bernard A. Schriever to Los Angeles to lead the new organization. Building on a unique formula of strong visionary leadership, technical expertise, and government-industry teamwork, the WDD pioneered the early stages of Air Force ballistic missile de-

While highly effective, what was noticeably absent was a major operational command responsible for defining requirements, advocating systems, developing comprehensive space personnel, training and doctrine, and promoting an operationally oriented space community within the Air Force.

velopment. The Division rapidly developed and fielded three first-generation missiles (Thor, Atlas, and Titan), and paved the way for development of future systems such as the Minuteman and Peacekeeper missiles. It was also assigned responsibility for the first Air Force satellite program, the Military Satellite System, or Weapon System 117L (WS 117L), which was transferred from Wright Air Development Center to the WDD in 1955.

The shock of Sputnik in 1957 accelerated the development of satellite systems and launch vehicles based upon the early ballistic missile work. By the end of 1959, WS 117L had evolved into three separate programs: the Discoverer Program, the Satellite and Missile Observation System, and the Missile Defense Alarm System. The rapid advances in space development were illustrated by the Discoverer program, which after 13 consecutive initial failures, went on to achieve numerous technological breakthroughs and mission accomplishments that became the hallmark for Air Force space. The early launch vehicles developed and used by the Air Force were based on Thor, Atlas, and Titan missiles, modified to serve as space boosters. NASA also used these vehicles (Atlas and Titan II) for early manned spaceflight, as well as the highly successful Delta launch vehicle.

Due in large part to this rapid expansion of technology and innovation during the 1960s and 1970s, the United States Air Force emerged as the clear leader in military space. Bolstered by the increased demand and dependence for space capabilities in the Cold War, space missions expanded dramatically in scope, capability, and reliability. Through the first quarter century of military space, Air Force Systems Command (AFSC) and Secretary of the Air Force Special Projects were the leaders in developing and fielding space capabilities for military and national users. They pushed technology boundaries and programs were driven by technology "push," as opposed to operational "pull." While highly effective, what was noticeably absent was a major operational command responsible for defining requirements, advocating systems, developing comprehensive space personnel, training and doctrine, and promoting an operationally oriented space community within the Air Force.

Figure 2. The Atlas missile achieves initial operational capability at Vandenberg AFB in 1959.

Figure 3. Thor Able 127 sits on the pad at Cape Canaveral with Pioneer 0, the first Air Force space launch, in 1958.

Figure 4. General Bernard Schriever, General Thomas White (Air Force Chief of Staff), and Col Charles Mathison with the film capsule from Discoverer 13 at Andrews AFB in 1960.

Air Force Space Command Stands Up

The call for a dedicated Air Force space operational organization was answered in 1982 as Air Force Space Command (AFSPC) was created to serve specifically as an operational command for military space systems. In the years that followed, Space Command gradually assumed responsibility for satellite operations, the eastern and western launch centers, and other space operations from AFSC. This restructuring in effect demonstrated the Air Force had made a priority of "operationalizing" and "normalizing" Air Force space. By creating space wings, formalizing training, developing space-career tracks, and advocating operational space systems and programs, the Air Force laid the foundation to develop and field space forces and capabilities, and to grow space leaders to create a critical mass of space expertise for the future. The creation of AFSPC represented a critical step in the maturation of space as an operational force in emerging joint warfare, plus recognition that space capabilities had advanced sufficiently to be more fully integrated with land, naval, and air operations. Coupled with growing Department of Defense focus on jointness and recommendations from the Goldwater-Nichols Act, the formation of AFSPC provided much-needed leadership to mature military space and better connect the space community with the joint warfighter.

Fragmentation of Space

While the formation of AFSPC served to galvanize the Air Force by designating a single major command responsible for delivering space capabilities, other events heavily influenced the broader National Security Space community. Military space became more fragmented with the formation of other organizations and agencies, all vying for a share of the space enterprise. Soon after AFSPC was created, United States Space Command was established in 1985, recognizing both the growing importance of space and acknowledging it was not an exclusive realm for the US Air Force. Divergent and divisive interests grew within the Air Force as roles and responsibilities continued to shift between AFSC, AFSPC, and the National Reconnaissance Office. Additionally, a new service acquisition-management structure was created, with the program executive officer and the assistant secretary of the Air Force for acquisition placed directly in charge of program-management execution. Other services created space commands and defense agencies, such as Defense Communications Agency and Strategic Defense Initiative Organization, began to develop and employ space capabilities to accomplish their organizational missions. These steps resulted in competition amongst the services, conflict and duplication, and general confusion regarding objectives of military space programs, desired operational capabilities, and roles, responsibilities, and accountability.

Acknowledged as the "first space war," Operation Desert Storm in 1991 proved that space would play a critical role in operational and tactical level warfighting. A prelude to the future, Operation Desert Storm clearly demonstrated that space would serve as a key enabler of joint warfighting. At the same time, the Cold War came to a close, and many significant organizational, program, and budget changes ensued. Strategic Air Command was dissolved, its air assets were transferred to the newly created Air Combat Command, and its ICBM forces moved to AFSPC in 1993. AFSC was merged into the new Air Force Materiel Command (AFMC). Military space organizational upheaval, coupled with newly created independent agencies, a lack of an overarching framework for space, and an ever increasing demand for space capabilities put a strain on the nation's ability to unify space efforts. Despite all the turmoil, the Air Force made steady progress throughout the 1990's, strengthening the roles and effectiveness of AFSPC. Rigor was brought to operational training, planning, and employment, discipline was applied to requirements and budgeting, and career leadership development improved.

Acknowledged as the "first space war," Operation Desert Storm in 1991 proved that space would play a critical role in operational and tactical level warfighting.

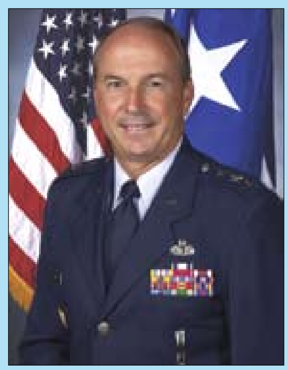
Figure 5. General Lester Lyles, Lt Gen Roger DeKok, and Lt Gen Brian Arnold during ceremonies observing SMC's transfer to Air Force Space Command in 2001.

Reversing the Trend

A key step towards combating the trend of fragmentation across the space enterprise occurred as a result of the Space Commission report of 2001. The Commission made a number of observations on the growing importance of space and recommended numerous improvements in space management. The panel called for steps to expand and enhance the space professional cadre through more deliberate education, training, leadership development and career management. The panel also recommended the Space and Missile Systems Center be realigned from AFMC to AFSPC, thus bringing military space developers and operators together under one major command. This represented a major shift in the management of military space programs and enabled space development and operations communities to focus and synergize their efforts to deliver space capabilities to the warfighter. It created a "cradle-to-grave" space command with full spectrum responsibility for military space, from concepts and development to acquiring, testing, fielding, to operating and sustaining space forces. Further, this move enabled the formation of a community that could provide the foundation for developing and growing a true space culture. From a workforce perspective, the realignment served to pave the way for development of robust space-professional culture and community with the knowledge and skills to develop, operate, and employ future space capabilities. Combining all segments of Air Force space provided the pool of talent from which space professionals would be grown as experts in the space medium, platforms, and operations with the ability to plan, execute, and employ the full range of capabilities and effects.

Leading the Future of Space

Today, AFSPC is the leader of military space capabilities for the nation and provides the vast majority of people, systems, infrastructure and funding to organize, train, and equip space forces. Drawing upon the history and experiences in space development and operations over the past 50 years, AFSPC has established itself as a "one-stop-shop" for the development, acquisition, testing, fielding, operations, and sustainment of space warfighting capabilities that assure the security and freedom of the nation. Military space has grown to be an effective and respected part of the joint warfighting team. In an era of increasing dependence on and unpredictable threats to our space based assets, the need for vigilance, vision, and focus has never been greater. AFSPC is building a space warfare community led by professionals recognized as the thought leaders for space, with the demonstrated ability to develop, operate, and employ space capabilities, while taking responsibility and accountability for the joint combat effects they produce. While some fragmentation continues across the space enterprise, the command has successfully demonstrated the leadership, talent, and dedication to seamlessly integrate space into the joint fight. In just 25 years, AFSPC has firmly established its reputation as the premier provider for military space, and the nation's true "Guardian of the High Frontier."



Lt Gen Michael A. Hamel (BS, Aeronautical Engineering, US Air Force Academy, Colorado; MBA, California State University) is commander, Space and Missile Systems Center, Air Force Space Command, Los Angeles AFB, California. General Hamel is responsible for managing the research, design, development, acquisition and sustainment of space and missile systems, launch, command and control, and operational satellite systems. He is responsible for more than 6,500 employees nationwide and an annual total budget in excess of $10 billion. General Hamel is the Air Force Program Executive Officer for Space and is responsible for the Air Force Satellite Control Network; space launch and range programs; the Space-Based Infrared System Program; military satellite communication programs; the Global Positioning System; intercontinental ballistic missile programs; Defense Meteorological Satellite Program; the space superiority system programs, and other emerging transformational space programs.

General Hamel was commissioned as a second lieutenant through the US Air Force Academy in June 1972. His career includes assignments in a variety of command, acquisition, operations, and policy positions involving space, system development, intelligence, space operations, and launch. The general has served in senior staff positions at Headquarters US Air Force and Air Force Space Command, and he was the vice president's military adviser on defense, nonproliferation and space policy. Prior to his current position, General Hamel commanded the 14th Air Force "Flying Tigers," and was responsible for all US Air Force space forces and operations as well as the execution of assigned US Strategic Command's space operations.

Realizing the Unthinkable:
AFSPC Influence Yesterday, Today, and Tomorrow

Maj Gen William L. Shelton
Commander, Joint Functional Component Command for Space, United States Strategic Command and Commander, 14th Air Force (Air Forces Strategic – Space), AFSPC

"We must dare to think "unthinkable" thoughts. We must learn to explore all the options and possibilities that confront us in a complex and rapidly changing world. We must learn to welcome and not to fear the voices of dissent. We must dare to think about "unthinkable things" because when things become unthinkable, thinking stops and action becomes mindless."

~ J. William Fulbright

Prior to World War II, few dared to imagine the possibility of Earth-orbiting satellites extending our ability to communicate around the globe. Decades later, Air Force Space Command (AFSPC) does the "unthinkable" and we take time to celebrate transitioning the impossible into the possible. We would not be where we are today without the visionary leadership of our forefathers, men such as General Henry H. "Hap" Arnold, General Bernard A. Schriever, and General James V. Hartinger. They championed what some considered foolhardy and set a course that AFSPC continues to chart today. For the last 25 years, AFSPC professionals persisted in delivering quality space capabilities to enhance our national security, protect lives and the environment, and serve as an engine for economic, diplomatic, and information growth. It has been an exciting journey and our contributions to military and national efforts show no sign of slowing. Space professionals are at the forefront in creating asymmetric advantages for decision makers in the air, out at sea, and on land. As we look ahead in providing the "unthinkable," we should take a moment to recount the achievements made yesterday and today, and seek out tomorrow's opportunities to proudly serve our nation.

Delivering Space Capabilities

"The United States considers space capabilities—including the ground and space segments and supporting links—vital to its national interests. Consistent with this policy, the United States will: preserve its rights, capabilities, and freedom of action in space; dissuade or deter others from wither impeding those rights or developing capabilities intended to do so; take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to US national interests."

~ US National Space Policy, 31 August 2006

In August 2006, the president signed a new National Space Policy highlighting the importance of space to the nation and guiding national space activities. Shortly after the end of World War II and following the Russian launch of Sputnik, Americans became interested in attaining the ultimate high ground for peaceful purposes. Through perseverance and savvy leadership, the Air Force emerged as the predominant service responsible for supporting space-based military objectives. Twenty-five years later, AFSPC strengthens US national interests by providing tailored, responsive, local and global space effects into every level of joint operations around the world.

Through our innovative and energetic space team, our space capabilities have never been more impressive than they are today. Our space- and ground-based assets, and their supporting links, enable the delivery of quality services and products to our military and civilian populations. Through position, navigation, and timing (PNT), missile warning, satellite communications, and meteorological observations, space is woven into the very fabric of our society. Our systems allow global reach of US Forces, support combat operations planning and execution, and provide the necessary top cover to keep our fellow Airmen, Soldiers, Sailors, and Marines out of harm's way. To ensure continuity of service, we have been upgrading or replacing aging space systems performing years beyond their intended design life. Our recapitalization efforts are just one aspect of how we deliver quality, capabilities-based space effects. General Arnold once said, "Present equipment is but a step in progress, and any Air Force which does not keep its doctrines ahead of its equipment, and its vision far into the future, can only delude the nation into a false sense of security."[1] We also continue to concentrate on recruiting and training space professionals, encouraging review and updates to joint and service doctrine, and participating in collaborative, real-world and exercise environments to refine tactics, techniques, and procedures.

Looking Ahead

In the November 2006 issue of *High Frontier,* General James E. Cartwright, commander of United States Strategic Command (USSTRATCOM), wrote, "The US must have the same capabilities in space as it does on the land, in the air, and at sea to defend its assets against hostile acts and to negate the hostile use of space against US interests."[2] Our nation's growing dependence on space-based capabilities creates a corresponding potential vulnerability. Therefore, preserving our space-based capabilities against intentional and unintentional events will be a growing challenge as more entities gain access to the space domain. Two significant events in the past year galvanized our thinking by highlighting both the importance and the potential fragility of our nation's space capabilities: the July 2006 North Korean launch of a Taepo Dong-2 missile and the January 2007

Chinese test of a hit-to-kill anti-satellite (ASAT) capability. In both events, space professionals coordinated pre-launch indications and warning campaigns, then provided space-based tracking of the boosters during flight, which helped shape the National response. We worked closely with our mission partners to ensure space capabilities were available to support potential contingencies and courses of action. For the ASAT test, we tracked the resultant debris, currently more than 2,000 pieces and increasing, and we continue to assess the additional risk posed by the debris to our satellites and the International Space Station. These events were reminders that we must think and act differently to sustain an asymmetric advantage on the battlefield. To that end, our priorities are: improving space situational awareness, enabling a net-centric, collaborative command and control (C2) environment, and strengthening interagency relationships to improve information sharing and response options.

Space Situational Awareness

In the 2007 AFSPC Strategic Intent document, General Kevin P. Chilton, AFSPC commander, stated, "We must—and we will—be prepared to deter, dissuade, and if necessary, defeat any adversary that seeks to deny us the ultimate high ground of space."[3] Part of being prepared is understanding the environment in which we operate to include understanding the intent of others in this same environment, our own resource limitations, and the natural environment in which we operate. As we migrate from a space surveillance mindset to a space situational awareness mindset, we realize understanding the location of a space object is just the beginning—we must also now strive to understand the purpose of that object, its capabilities, and the intent of its owner. This knowledge, in the hands of a decision maker, enables the rapid selection of effective courses of action to mitigate that object's effects on our capabilities. Space situational awareness is the foundation upon which successful space control actions can achieve the desired space superiority to enable joint operations. Collecting and sharing this SSA in a net-centric, collaborative C2 environment is essential to the delivery of timely decision-quality information and knowledge.

Enabling a Net-Centric, Collaborative C2 Environment

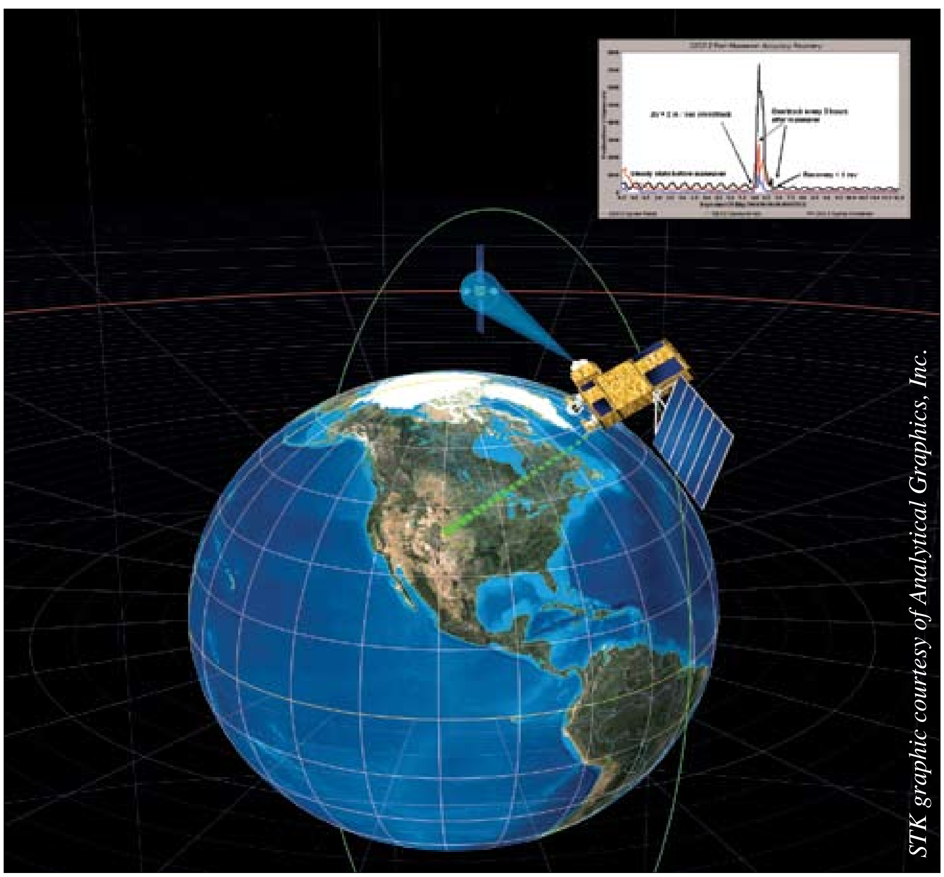
"The teams and staffs through which the modern commander absorbs information and exercises his authority must be a beautifully interlocked, smooth-working mechanism. Ideally, the whole should be practically a single mind."

~ General Dwight D. Eisenhower

Success in combat is achieved through unity of effort amongst a variety of parties. It is no different in the space community. The creation of AFSPC itself was due to the recognition that multiple organizations, with multiple objectives, were at times, at cross-purposes. In today's environment of multiple commitments and limited resources, the Department of Defense (DoD) continues to examine opportunities to improve operational effectiveness in support of national objectives. Within the past year, both the joint warfighter and the Air Force service provider established organizational structures as one method of achieving unity of effort.

The first organizational change occurred in July 2006 when General Cartwright, in coordination with the chief of staff of the Air Force (CSAF), created a Joint Functional Component Command for Space (JFCC Space) and assigned the commander, 14th Air Force (14 AF), that dual commander role. This change provided a single commander, with a global perspective, the ability to enhance functional integration of space capabilities into offensive and defensive operations such as global strike and global missile defense.

The second organizational change occurred in May 2007 with the implementation of the CSAF-directed Component Numbered Air Force structure which redesignated 14 AF as 14 AF (Air Forces Strategic - Space [AFSTRAT-SP]), and redesignated the 614th Space Operations Group as the 614th Air and Space Operations Center (614 AOC). In this role, 14 AF (AFSTRAT-SP) becomes the Air Force's space operations component to USSTRATCOM and



Maneuver detection of Earth-orbiting spacecraft is a key technology involved in providing our nation with enhanced space situational awareness.

provides centralized C2 over all Air Force forces assigned or attached to the combatant commander.[4] The mission of 14 AF (AFSTRAT-SP) remains the same—we provide space superiority through surveillance, warning, and battlefield characterization; enable assured access to space; and support C2 activities at all levels of war. The organizational change now provides direct contact between the commander, USSTRATCOM, and a single, operational Air Force commander directing Air Force space forces. Air Force space forces are directed through the 614 AOC, which also forms the core capability of USSTRATCOM's Joint Space Operations Center, which is where joint (Air Force, Army, Navy) space forces are directed by the commander, JFCC SPACE.

Strengthening Interagency Relationships

Strengthening interagency relationships with a variety of organizations, to include the National Reconnaissance Office (NRO), National Security Agency, National Geospatial Intelligence Agency, NASA and the National Oceanographic and Atmospheric Agency, improves information sharing and opens the door to consider multiple courses of action for decision makers. As the Honorable Dr. Ronald M. Sega, undersecretary of the Air Force, highlighted in his 2007 Congressional testimony, "We continue to emphasize integration and collaboration across the national security space community; across functional areas such as intelligence, surveillance, and reconnaissance; and among DoD entities, other government agencies, industry, academia, and Congress. Integrating architectures also becomes increasingly important as systems become more capable of dynamic tasking and mutual cueing, and protection of our space capabilities become even more important."[5] To advance these efforts, the Air Force and NRO signed an agreement to establish mechanisms for developing and managing space professionals both in support of military and national objectives; the NRO's deputy director for Mission Support was dual-hatted as the deputy commander for JFCC SPACE, and a new NRO position was established at Headquarters AFSPC as the deputy director of Air, Space, and Information Operations. Additionally, senior-level councils and collaboration summits occurred to support improvements in space intelligence collaboration initiatives. The goal is to train like we want to fight, and building partnerships in peace will pay large dividends in the heat of battle.

The Way Ahead

President John F. Kennedy prophetically said, "This nation has tossed its cap over the wall of space, and we have no choice but to follow it. Whatever the difficulties, they will be overcome. Whatever the hazards, they must be guarded against—with the help of all those who labor in the space endeavor, with the help and support of all Americans, we will climb this wall with safety and with speed—and we shall then explore the wonders on the other side." As we plan for the future, one thing is certain: space capabilities will be called upon at an increasing rate and it will be up to the men and women standing watch today to present a future that provides persistent, predictive space capabilities for the nation. As AFSPC celebrates its first quarter century, we not only look back at a proud past; we look ahead to all that we can become and all that we can do to further our nation's goals. Space systems can only carry us so far, the rest is up to us, the space professionals. We must identify efficiencies, seek out opportunities to exercise our capabilities, and continue to chart a path to deliver quality, timely, and accurate space effects to our Airmen, Soldiers, Sailors, and Marines on the ground, in the air, or at sea. Our nation requires our vigilance and our perseverance in order to explore the wonders of space.

Notes:

1 David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership* (Revised Edition), (Washington DC: Air Force Space Command in association with Air University Press, 1998), 10.

2 General James E. Cartwright, "Assured Access to Space," *High Frontier* 3, no. 1 (November 2006), 3.

3 "2007 Air Force Space Command Strategic Intent," April 2007, http://www.afspc.af.mil/shared/media/document/AFD-070412-128.pdf.

4 Headquarters United States Air Force (HQ USAF) Program Action Directive (PAD) 06-09, "Implementation of the Chief of Staff of the Air Force Direction to establish an Air Force Component Organization," 7 November 2006.

5 Honorable Ronald M. Sega, under secretary of the Air Force, Department of the Air Force to the House Armed Services Committee Subcommittee on Strategic Forces, statement, National Security Space Posture, 23 March 2007, 6-7, http://armedservices.house.gov/pdfs/Strat032307/Sega_Testimony032307.pdf.

Maj Gen William L. Shelton (BS, Astronautical Engineering, USAFA; MS, Astronautical Engineering, AFIT) is commander, Fourteenth Air Force (Air Forces Strategic-Space), Air Force Space Command, and the Commander, Joint Functional Component Command for Space, United States Strategic Command (USSTRATCOM), Vandenberg AFB, California. As the Air Force component commander for operational space forces to USSTRATCOM, he leads more than 20,500 personnel to provide missile warning, space superiority, space situational awareness, satellite operations, space launch and range operations in support of combatant commander objectives. As CDR JFCC SPACE, the general directs USSTRATCOM's assigned and attached space forces and provides tailored, responsive, local and global effects in support of National, USSTRATCOM, and combatant commander objectives. General Shelton entered the Air Force in 1976 as a graduate of the US Air Force Academy. He has served in various assignments, including research and development testing and space operations. The general has commanded at the squadron, group and wing levels, and served on the staffs at major command headquarters, Air Force headquarters and the Office of the Secretary of Defense. Prior to assuming his current position, General Shelton was the director of Plans and Policy (J5), USSTRATCOM, at Offutt AFB, Nebraska.

ICBMs Past, Present, Future and Air Force Space Command's Critical Role

Maj Gen Thomas F. Deppe
Commander, 20th Air Force

I am honored to write this article for the *High Frontier* celebrating "Air Force Space Command's (AFSPC's) 25th anniversary." Has it really been that long since the birth of this great command? So much has happened in such a short period of time that anyone looking at AFSPC's future knows the pace will be fast, and exciting. In an era of transformation, one thing we can be sure of, AFSPC in the year 2032 will be much different than 2007.

In developing this article, I reflected on 20th Air Force's (20 AF) role in AFSPC's history, where 20 AF fits in today, and what the future holds for 20 AF and AFSPC. As the commander of our nation's intercontinental ballistic missile (ICBM) force, I am motivated to write about where we should go with the proven capability that our ICBM force provides. Over the past two years, the men and women of 20 AF have proven to be very effective change agents in our Air Force. No longer do we rest on our successes from the Cold War. Instead, we are transforming our current capabilities to ensure we provide effective deterrence today and even greater combat capability for our nation in the future.

ICBMs have traditionally had responsiveness as an operational trait. But, the responsiveness of our system should be redefined as 20 AF moves forward. We need to develop and maintain the flexibility in planning and operations needed to respond and adapt to a rapidly changing world. Therefore, this article will articulate how we should continue to provide unrivaled capability to influence adversary decisions (deterrence) while at the same time providing decisive kinetic effects on targets down range.

A vital aspect of this transformation is to continue the discussion General Kevin P. Chilton, AFSPC commander, began last year when he called for AFSPC professionals to ponder current and future challenges to strategic deterrence.[1] He asked challenging questions regarding the role AFSPC plays in the 21st century national security environment. General Chilton also challenged AFSPC personnel to "think beyond accepted definitions of strategic deterrence and carefully crafted scenarios, and challenge yourself to answer not only today's questions but also tomorrow's!"[2]

These provocative questions lay the foundation for the future relevancy of ICBMs. These questions must be pondered; they must be debated; they must be answered, and answered soon. We cannot afford surprises, nor can we afford vulnerabilities that will, no doubt, be exploited by future adversaries. We need to ensure we fill all gaps in our current capabilities. Our nation's military is the best in the world—no one comes close! However, that does not mean we can rest on our successes nor accept gaps in our capabilities. Furthermore, we need hardware and software capabilities, doctrine, organization, training, materiel, leadership, and personnel to respond to any future enemy and their chosen methodology for prosecuting warfare, ranging the full spectrum of conflict. We need to continue growing combat capabilities and ICBMs need to be an integral part of that future—I submit in both a nuclear and a *conventional* role.

Our primary focus is to prepare 20 AF for the strategic deterrence challenges of this century. Creating technology for its own sake is not what military space professionals should be aspiring to accomplish. We should develop the combat capabilities needed by the nation to provide options to cover the full spectrum of conflict. In the August 2006 issue of the *High Frontier,* I asked a number of questions to initiate this dialogue. My assertions were to promote critical thinking on warfighting; some questions centered on strategic deterrence and the ICBM in a conventional or nuclear role:

- What weapons system will replace the ICBM?
- What new weapon will give us an immediate global strike option?
- How would we employ this new technology as a weapons system?

I hope to encourage the debate throughout the command. In order to have the educated discussions about the future ways of war for the ICBM, one must understand where we came from, where we are currently, and where we are going as a command. In this article, I will touch on ICBMs past, present and future, and discuss AFSPC's contributions to our weapon system.

Brief History of ICBMs

Following World War II, our nation found itself in the midst of an ideological struggle with Communism. All instruments of our national power—diplomatic, information, military and economic—were exercised and exhausted in an effort to contain Communism. The "big stick" that remained within the reach of world leaders was the nuclear weapon. This period required deep reflection by strategic thinkers to envision the purpose of such a destructive capability. From that strategic environment, effective policy was formulated resulting in deterrence theory. For the US, deterrence became part of our every day lexicon.

Concepts of strategic deterrence began to emerge during the late 1940s and 1950s.[3] As the Soviet Union and US began an arms race that dominated the international scene, ICBMs played a pivotal role. During those early days of the Cold War, policy makers and strategists debated strategic deterrence meaning and policy initiatives, often arguing back and forth the role and purpose of nuclear weapons in defense of our nation as compared

Figure 1. Early intercontinental ballistic missiles were liquid-fueled and dangerous to handle from the manufacturing line through employment of the weapon. Future upgrades and designs allowed for solid fuel and a safer missile.

to conventional weapons. As one might expect, the debates included technical, political, and even moral components.[4]

ICBM roots date back to General Bernard A. Schriever and the "Schoolhouse Gang" of the 1950s. The Air Force established the Western Development Division during that period, its first task was the development of ICBMs (Atlas, Titan, Thor, and Minuteman). The genesis of the ICBM was problematic and an extremely risky undertaking that would produce "a complex system requiring specially designed facilities and highly trained technicians."[5] Moreover, the Atlas and Titan "were temperamental weapons fueled with dangerously volatile liquids."[6] Though the beginnings looked bleak, General Schriever was given complete autonomy, responsibility, and authority for ballistic missile development and he ensured the program was a complete success. This was no small task, as to many, the ICBM program "proved comparable to the Manhattan Project of World War II."[7] As the ICBM matured as a weapon system, its use as an effective strategic deterrent was realized as US/Soviet tensions mounted during the early 1960s.

The role ICBMs played during the Cold War cannot be overstated. As Lt Gen Frank G. Klotz, vice commander of AFSPC, asserted: "During the Cold War, our strategic nuclear deterrence forces, including the ICBM, were the mainstay of our nation's defense posture. Their primacy was reflected in fact by their designation as Major Force Program 1 within the defense budget."[8] Deterrence strategies ranged from conveying the purpose of nuclear weapons as war ending assets and war fighting assets to war prevention assets.

Since the beginning of the Cold War, our country has witnessed some changes in nuclear weapons strategies as the various presidential administrations entered office.[9] According to David M. Kunsman and Douglas B. Lawson, a certain set of principles regarding the use, or threatened use, of nuclear weapons has endured. These principles are best conveyed in the form of provocative questions:

> "For what purpose does the US have nuclear weapons? Are they a sword or are they just a shield, that is, do they exist to fight wars if necessary or do they exist only to prevent wars? If they exist to fight wars, are they to be used in a limited (less than the entire inventory) fashion? If so, how are such wars, once initiated, stopped? If they are not for war fighting but just for war prevention, how do we signal to potential adversaries that we will use them if necessary so that they *know* we will use them? Should preemption against a developing threat be a possible US policy, or is it never to be an option? What about preventive strikes as another side prepares to shoot at the US? Should the US allow itself the option of striking first, without warning? Would such a policy be at odds with fundamental US principles? Would these policies, if implemented and announced, be de-stabilizing in a crisis?
>
> What is the proper allocation of defense resources first between conventional and nuclear forces, and, second, among the various elements of the nuclear forces?"[10]

According to Kunsman and Lawson, the following principles have been the guide for our policy makers:

> "Nuclear weapons exist fundamentally to deter nuclear attack against the US and its allies.
>
> War plans [and weapon system capabilities] have provided flexibility and options to the National Command Authorities.
>
> Sufficient nuclear forces (and associated command and control) are maintained to assure their survivability and capability to inflict 'unacceptable damage' to any adversary, even if that nation strikes first."[11]

As mentioned earlier in this article, due to the incredible efforts of General Schriever's team, ICBMs recovered from their tenuous beginning to become our preeminent weapon system. During the 1990s, ICBMs and strategic deterrence policy were credited with winning the Cold War; the Soviet Union dissolved and Russia became an international partner. The US military had evolved its precision conventional weapons capabilities exponentially year-by-year. The result of this incredible leap in technological capability was that no other country could compete militarily with the US on the world stage.

With the Cold War in the rearview mirror, many policy experts in government and academic circles debated the relevancy of ICBMs and nuclear weapons and their place in the national security structure. At the same time, space began to prove its value in future warfare by directly contributing to success in Operation Desert Storm. This was the overarching context of the times when ICBM history and AFSPC history crossed paths.

ICBMs Present and AFSPC's Role

During the 1990s, the ICBM mission experienced significant reductions. We have many policy makers who remain interested in keeping a robust nuclear deterrent capability. This fact is evident in the Nuclear Posture Reviews and the various Defense Science Board reports on the value of nuclear weapons. There is strong, and almost unified, consensus from our national leaders that we do need to maintain a robust, reliable, safe, and secure nuclear deterrent capability. However, there are many divergent views as to the purpose of that capability.[12] Do we exist to deter peer and near-peer state actors who have robust nuclear capabilities of their own? Do we exist to contribute to deterrence of other forms of weapons of mass destruction (biological and chemical)? Do we exist to dissuade competition—a benefit in the area of non-proliferation? We are continuing the reduction in our forces to meet the number of operationally deployed weapons according to the Moscow Treaty. As we move down this path, the time is now to identify and articulate our purpose. ICBM warfighters of the Cold War had a well-defined purpose; current ICBM warfighters are not given that luxury.

Our ICBM force fits into the defense of our nation in significant ways not often discussed. We need to communicate a coherent message that conveys who we are, and what we do for national security purposes in the post 9-11 world. Reductions to our strategic forces are necessary in the current strategic context. However, it is important to emphasize that 20 AF is also modernizing the entire weapon system in order to contribute to US national security. Bottom line: ICBMs are no less important today than they were during the Cold War. General Chilton has stated that in the face of reductions our ICBM weapon system remains important: "The need for strategic deterrence has not gone away, particularly given the possibility that additional nations could develop and field weapons of mass destruction, as well as the means to deliver them."[13] The nation will need a nuclear deterrent for the foreseeable future because the world remains a dangerous place. We must ensure we have responsive capabilities, nuclear and conventional, to cover the full spectrum of conflict. Any gap in our capabilities is a vulnerability that can be exploited by our enemies.

ICBMs also provide a diplomatic and non-proliferation benefit vis-à-vis our extended nuclear deterrent. Friends and allies are assured by a promise that so long as we remain capable of extending that nuclear deterrent umbrella, they need not develop nuclear capabilities of their own. Therefore, we can ill-afford to allow our nuclear infrastructure and nuclear weapons complex to go without attention in the coming decades.

The elimination or reduction of the ICBM force invites a potential "sprint to parity" by our competitors or enemies. We should maintain a sufficient margin in our strategic capabilities to "deter, dissuade, deny, and, if necessary, defeat."[14] At a minimum, we should seek to avoid surprise or hedge against a catastrophic failure in a particular system. We should continue to fund ICBMs as a matter of national policy; it is a wise and economical investment given the fact ICBMs require less than one percent of Air Force total obligation authority.

One of General Chilton's four strategic priorities for our command is to "provide safe and secure strategic deterrence. With a readiness rate above 99 percent, America's ICBM team plays a critical role in maintaining world peace and ensuring the nation's safety and security. The ICBM force consists of Minuteman III missiles that provide the critical component of America's on-alert strategic forces. As the nation's 'silent sentinels,' ICBMs, and the people who operate them, have remained on continuous, around-the-clock alert since 1959—longer than any other US strategic force."[15] Furthermore, the Minuteman III is being upgraded from nose cone to nozzle. AFSPC has heroically provided the resources needed for these necessary upgrades to the tune of over $6 billion.

I cannot stress enough the major undertaking the professionals of 20 AF are working, and have been working, in the ICBM fields stretching the size of the state of Pennsylvania. We are upgrading the booster by re-pouring the solid propellant in each of the three downstages. We are replacing the guidance set and the older warheads. The ground support equipment, command and control equipment and environmental control equipment at both the launch facility and the launch control center, too, are being replaced. These efforts will extend the life of our Minuteman force to 2020. Now, with the harvesting of assets by deactivating the 564th Missile Squadron at Malmstrom AFB, Montana, we will have the test assets and reliability to extend the life of the current system to probably 2030. As we consider the health of our nuclear forces, we should avoid doing patch work to get us from one decade to the next. At some point, we need a serious study on recapitalizing our entire infrastructure. Should we be in the business of providing component upgrades to our capabilities in an effort to extend the service life of the Minuteman? Or, should we be in the business of a transformational initiative that provides for a new and improved weapon system capability? According to the December 2006 Defense Science Board report on nuclear capabilities, while we focus on extending the life of our ICBMs, we do not have a production complex that can sustain the effort. And, we do not have the organization, management and programs to meet future needs of our nuclear weapons enterprise.[16]

The ICBM currently provides the most expedient resource for a global strike mission. Today, though, our ICBM force gives national leadership one option—nuclear. As ICBM professionals with the resident warfighting expertise, we need to move out faster on developing the capability to deliver conventional effects at global distances within a matter of minutes. The combat focus and mindset possessed by our personnel is essential to a proactive approach toward conventional missile acquisition in order to provide combat effects to USSTRATCOM and the nation. We are doing a superb job on increasing the lifespan of the Minuteman III, given the resources available. But, we can do more. The challenge today is great. The value of the ICBM force is high, but the need for increased ICBM capability through conventional application is vital to future security challenges.

ICBMs Future and How AFSPC Can Contribute

Will AFSPC field a conventional strike capability, something lacking within the current inventory? In recent testimony before the House Armed Services Committee Strategic Forces Subcommittee, General James E. Cartwright, commander, USSTRATCOM, on 8 March 2007, stated, "We require a robust mix of capabilities tailored to a wider range of potential adversaries and spectrum of challenges than yesterday. We have a prompt delivery capability on alert today, but it is configured with nuclear weapons, which limits the options available to our decision-makers and may reduce the credibility of our deterrence. The capability we lack is the means to deliver prompt, precise, conventional kinetic effects at inter-continental ranges."[17] As mentioned earlier, we need to redefine responsiveness for the ICBM force. Not only should we be responsive operationally, we should be responsive enough to adapt to changing needs of our national leaders and combatant commanders. General Cartwright continued, "Air Force Space Command is developing a promising concept for a CONUS-launched conventional strike missile, which capitalizes on the maneuverability and precision-to-prompt-effects offered by maneuvering flight technology to produce effects at global distances."[18]

Figure 2. Constant and continuing upgrades to virtually every component and system on the Minuteman III ensure its safe and reliable service through 2020.

The need for a conventional ICBM answers General Chilton's "call to provide the president with a wider, more flexible range of options."[19] Mr. Frank Miller, also in the August 2006 *High Frontier*, said, "it is important that the Air Force continue to investigate the feasibility of using ICBMs to deliver conventional payloads."[20] My goal as 20 AF commander is to put the most capable "tools" in the president's "toolbox." Increased capability means increased options. We need current ICBM operators to be energetic about what they do and the critical skill sets they provide for our nation. If a conventional capability is developed, who do we expect will conduct the mission? I would argue that the current generation of missileers are more than capable of taking on the task. Missileers understand operations, standardization, and evaluation. Missileers understand tactics, planning, and possess a persistent combat focus.

As our Air Force is buying F-22s to modernize the fighter force, we are also upgrading the Minuteman III. Both efforts go toward the Air Force chief of staff's challenge to recapitalize the Air Force. Like the F-22, the Minuteman III provides a capability to national leadership—the capability could be in the form of nuclear or conventional. Ultimately, both weapon systems contribute to deterrence by being able to deliver tremendous combat effects. In the case of the ICBM, it is the "top cover" for our nation.

Conclusion

With this article, I have attempted to take you on a brief ICBM journey. The purpose of the trip was to help us all remember the war-winning contribution of operationally responsive ICBMs to the deterrence strategies of the Cold War era. ICBM relevancy during the Cold War was unquestioned, their role and purpose was clear.

As we celebrate the 25th anniversary of AFSPC, the role of the ICBM is just as clear. AFSPC and 20 AF must continue to provide a safe, secure, nuclear strike capability but we must also take this proven capability and use it to fill the gap that General Cartwright has for a "prompt, precise, conventional kinetic effect at intercontinental ranges." Creating such a capability will provide USSTRATCOM and the president a conventional strike missile that addresses the strategic deterrence challenges of the 21st century.

Notes:

[1] General Kevin Chilton, "Strategic Deterrence in the Post Cold War/911 Era," *High Frontier* 2, no. 4 (August 2006) 3.

[2] Ibid., 3.

[3] David M. Kunsman and Douglas B. Lawson, "A Primer on US Strategic Nuclear Policy," SAND2001-0053, unlimited release, January 2001, sect. 2, http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2001/010053.pdf.

[4] Ibid., sect. 2, 15.

[5] Bernard C. Nalty, ed, *Winged Shield, Winged Sword, A History of the United States Air Force, vol II, 1950-1997,* (Washington DC: USAF, 1997), 86.

[6] Ibid., 86.

[7] Ibid., 88.

[8] Lieutenant General Frank G. Klotz, transcript of speech to National Defense University Breakfast, 13 June 2006.

[9] Kunsman and Lawson, sect. 2.

[10] Ibid., 69.

[11] Ibid., 69.

[12] Defense Science Board, "Report of the Defense Science Board Task Force on Nuclear Capabilities," 23 December 2006, 1.

[13] General Chilton, "Strategic Deterrence," 2.

[14] Joint Chiefs of Staff (JCS), *National Military Strategy of the United States of America 2004* (Washington DC, 2004), 2.

[15] Air Force Space Command (AFSPC), fact sheet, http://www.af.mil/factsheets/factsheet.asp?fsID=155.

[16] Defense Science Board, "Report of the Defense Science Board," 1.

[17] General James E. Cartwright, statement before the Strategic Forces Subcommittee of the House Armed Services Committee, congressional testimony, 8 March 2007.

[18] Ibid.

[19] General Chilton, "Strategic Deterrence," 2.

[20] Franklin C. Miller, "Intercontinental Ballistic Missiles in the Twenty-First Century," *High Frontier* 2, no. 4 (August 2006) 5.

Maj Gen Thomas F. Deppe (BA, Management, Tarkio College, St Louis, Missouri; MS, Systems Management, University of Southern California) is commander, 20th Air Force, Air Force Space Command, and Commander, Task Force 214, US Strategic Command, F. E. Warren AFB, Wyoming. He is responsible for the nation's intercontinental ballistic missile force, organized into three operational space wings with more than 9,600 people.

The general was commissioned in 1977 through Officer Training School. He has held various wing and headquarters-level positions in intercontinental ballistic missile, space, and maintenance operations.

General Deppe has commanded a ground launched cruise missile flight in NATO and a Minuteman II maintenance squadron in Air Combat Command. He also commanded a Minuteman III missile wing, an ICBM logistics group and was vice commander of a space launch wing in Air Force Space Command. He has also served as deputy director for operations at the National Military Command Center. Most recently he served as director, logistics, and communications, chief information officer and chief sustainment officer, Headquarters AFSPC, Peterson AFB, Colorado. He is a master missileer in both operations and maintenance.

General Deppe is also a graduate of Squadron Officer School, Armed Forces Staff College, and Air War College.

Forward to the Future: A Roadmap for Air Force Space (Part I)

Col J. Kevin McLaughlin
Commander, Space Development and Test Wing
Col Chris D. Crawford
Commander, 21st Operations Group

Introduction: 11 January 2007

In one millionth of a second, the Chinese Feng Yun 1C polar orbit weather satellite ceased to exist. The Chinese direct ascent anti-satellite (ASAT) vehicle had slammed into and vaporized the ill-fated weather satellite in a successful demonstration of Chinese ASAT capabilities. While the event caused a stir in many governments around the world, military leaders in the United States were not surprised or caught unaware. They had been focused on the threat caused by the Chinese ASAT and other capabilities that might harm our assets in space. One of those key leaders, General Kevin P. Chilton, commander of Air Force Space Command (AFSPC), commented recently in Congressional testimony that the Chinese test in January might signal a less than peaceful future in space. In terms of being able to deal with this current threat and some of its challenges, General Chilton stated, "I think we're on the right track. We are chartered not only to look at how we support today's fight, but also we have to look to the future as well."[1]

The focus of this two-part article is "the future" mentioned in General Chilton's comments. There is a strong conviction that the nation will be vitally dependent on Air Force space personnel and capabilities in the future. Though there are signs of progress on some fronts, the Air Force space community has struggled in the past to define a future path toward the military capabilities that are the keys to the nation's most pressing needs. This is bad news for the United States unless strong steps are taken. Missing from the literature is an overarching, prescriptive paper that defines what the problems are and targets short-term actions to address those problems.

Part I of this article takes a retrospective look at Air Force space culture with an emphasis on how our culture is shaped and defined by our history. Culture is emphasized as the key ingredient that will power our ability to move into the future.

Part II of this article, to be published in the next edition of *High Frontier,* will address four separate focus areas; each with detailed findings and recommendations that are the specific steps we believe should and can be implemented immediately to meet the future challenges referred to by General Chilton.

This article is not targeted at the National Security space environment, however, National Security space issues will be mentioned when they are central to the Air Force discussion. Our intent is not to criticize or second-guess decisions from the past or current efforts within the Air Force. This discussion is a critical analysis intended to drive a vigorous and healthy debate on these critical issues. Such a debate is essential in Air Force professional circles and the fruits of that debate *must lead to action!* Without action, Air Force space capabilities and their relevance to national security will fade.

The Future: 13 November 2025[2]

"For countries that can never win a war with the United States by using the method of tanks and planes, attacking the US space system may be an irresistible and most tempting choice. Part of the reason is that the Pentagon is greatly dependent on space for its military action." ~ Wang Hucheng[3]

In less than five days, the Chinese had established strongholds around Taiwan with several divisions of elite ground forces. The Americans, now faced with a protracted bombing campaign at best, or at worst, a massive amphibious assault to dislodge the Peoples Liberation Army (PLA) and the potential loss of billions of dollars of critical space assets, quickly decided that the costs to "free" Taiwan would not be acceptable. The People's Republic of China had not only brought the long separated "province" back into the fold, but had also proven to the world that US power could be challenged in the types of large scale engagements they had long dominated.

In the US, the political and military shockwaves were just beginning. The president had already accepted the resignation of the chairman of the Joint Chiefs of Staff and the commander of AFSPC. Despite several decades of planning and exercises, the US had been fooled by the Chinese attacks on Guam and US naval forces in the western Pacific. These attacks, while on the surface a major defeat for the PLA, were a successful feint that kept US power projection platforms out of the fight that mattered most to the Chinese government.

The Chinese main effort was an amphibious assault on the island of Taiwan, supported by 2,500 ballistic and cruise missiles and dozens of special operations teams. Though the Taiwanese fought ably, their only chance at victory lay with the US military. That chance never materialized. The US Air Force, flying out of limited bases on Japan, could not bring sufficient forces to bear to respond effectively. The American Navy was tied up in the attacks on Guam.[4] The greatest shock to the American military was in the space realm. The technologically sophisticated Chinese military was backed by an integrated joint command and control and intelligence, surveillance and reconnaissance system that included terrestrial systems and dozens of Chinese-owned and third party satellites. In the three days before the attack the PLA launched eighteen single-use, short-duration micro-satellites to increase capability and provide redundancy against the inevitable US countermeasures. At the onset of combat operations, two US military geosynchronous satellites over the Pacific theater suddenly stopped working. US space operators had no indications of any attack other than decoded messages sent by the Chinese through diplomatic channels. These messages indicated that the two failures were not coincidental and that any American bombing close to Chinese cities or an attempted landing on Taiwan would "force" them to permanently disable large numbers of US military and national satellite systems from low-Earth to geo-synchronous orbits. The American space leadership was unable to bring any capability to bear in defense against the Chinese space threat or in support of operations against other Chinese forces.

Forward to the Future

"The advantage the US military derives from mastery of space is slowly eroding …" ~ Max Boot[5]

Is this future inevitable? Of course not. However, the fictitious scenario above is not fantasy. The Department of Defense's (DoD's) 2007 China Military Power Report details China's expanding military capabilities, their goal of altering regional military balances, and their focus on global military capabilities (including cyber and space) that expand their reach beyond Taiwan.[6]

China is in the midst of a focused set of investments aimed at neutralizing perceived US advantages that include: the ability to project exact levels of force very precisely; advanced manned and unmanned systems able to penetrate heavily defended areas; the ability of small numbers of platforms to deliver ever increasing levels of lethality; highly integrated command and control systems, which provide information sharing and a common battlefield picture to individual operators throughout all mediums of operations; the ability to gather, filter, integrate, analyze, process, and deliver information from space and other platforms. This information would be tailored for specific theaters, and delivered in usable forms to individual operators and low level unit control centers within minutes.[7] It is not unreasonable to expect that, by 2025, Chinese development could include: the ability to effectively operate more advanced integrated systems, a mixture of active radio frequency and advanced optical tracking systems for tracking of air and space systems; electronic warfare systems designed to jam, or even alter and deceive US sensors by using enhanced signal processing techniques designed to defeat spreading and other anti-jamming technologies; surface to air and surface to ship missiles that are able to actively track targets using onboard processors and a combination of radar, infrared detection, and laser technologies; and directed energy systems designed to shut down onboard electronics of ships, aircraft, spacecraft, and information processors.[8]

Perhaps more importantly, China is pursing capabilities to provide their own freedom of action in space, which seems to be the key to their future military strategy. The scenario assumes several key steps in the development of Chinese space capabilities to include: development of a robust space-based navigation system and the ability to deliver munitions precisely; a successful program to reduce satellite size and increase launcher flexibility resulting in a Chinese military satellite that is very robust, capable, and difficult to track; deployment of several types of sophisticated reconnaissance programs, allowing them to track movements in the region day and night, and in all types of weather; programs making denial and deception very difficult and providing increased ability to detect and track US space systems.[9] Finally, it assumes they have deployed a multi-layered counterspace architecture with capabilities ranging from small area denial of uplinks and downlinks to the ability to damage or destroy US satellites up to a geosynchronous orbit.[10]

The United States space position in the scenario is equally plausible. In the scenario, the US was unable to bring meaningful space capabilities to bear in support of the US response, unable to deny Chinese forces freedom of action in space, and unable to defend its space assets. This future is highly plausible given the current path that the US and China are on vis-à-vis space. While there is increased focus at senior levels, the Air Force space community is not yet producing the results our nation needs.

Today, space capabilities provide global information utilities and comprehensive surveillance and reconnaissance, and are critical to the nation and specifically to our edge in military power. They are intertwined into every aspect of our operations. The US currently owns a decided edge in space capabilities that has contributed mightily to victory in the Cold War, and stunning successes in Desert Storm and Iraqi Freedom (major combat phase). However, with delays in the procurement of replacement systems, growing fragmentation, the failure to pursue new innovative concepts, and the efforts of other nations to deploy more advanced capabilities, the US advantage in the medium of space is beginning to erode. In addition, there are current and emerging military needs that could and should be met by new space capabilities. Maintaining our military edge is not a foregone conclusion. If AFSPC simply maintains the status quo, it is unlikely we will deliver the capabilities required by our nation. This decline is not because the technology to do more does not exist, and not because new capabilities could not be brought to bear to "push the envelope" as happened in the 1960s and 1970s, but because the professional space community has been unable to establish a common vision and a set of consistent objectives to pursue over the years. American military history is not replete with examples of major self-reform. However, given the importance and potential of space missions, internally focused reflection with a critical eye toward the future and a focus on self-reform is essential now.

Foundational Findings

- US space capabilities are critical to the national economy and integral to our warfighting capability.
- The US lead in space capabilities is beginning to erode.
- Future combat will require space forces able to deliver effects that we are not on a path to field or operate effectively.
- Significant, likely controversial, changes are needed now. Developing an overarching space culture and a set of mission focused sub-cultures is critical to sustaining positive change.

The first three findings are the basis on which the remaining discussion will build. These foundational findings are presented as assertions to begin the detailed diagnosis of AFSPC. Some may debate them. Although this debate is needed and would be useful in terms of fleshing them out further, it is not the focus of this article. Our primary audience consists of those who accept the first three findings and are willing to consider the fourth. The remainder of the article (Part I and II) is dedicated to examining AFSPC and recommending what those changes should be.

Culture: The Critical Missing Ingredient

The Airman's Creed[11]

I am an American Airman. ***I am a warrior. I have answered my nation's call.***

I am an American Airman. My mission is to fly, fight, and win. I am faithful to a proud heritage, a tradition of honor, and a legacy of valor.

I am an American Airman, guardian of freedom and justice, my nation's sword and shield, its sentry and avenger. I defend my country with my life.

I am an American Airman: ***Wingman, leader, warrior. I will never leave an airman behind, I will never falter, and I will not fail.***

A strong Air Force space culture, and a set of mission focused sub-cultures, is needed to drive cohesive behavior at every level and to ensure the Air Force can deliver the capabilities required by our nation in the future. In particular, we must drive towards a culture that combines a strong warrior ethos with a deep understanding of our operational art and world-class technical skills.

Our Air Force space culture is driven by our history. Over the past four decades, events have transpired that have significantly impacted our culture. These events, each driven by factors that made sense at the time, have created an Air Force Space culture that is dominated by a strategic mindset, but further diluted by artificial distinctions between competing functional communities and the merger of too many dissimilar functions. Most space officers lack in-depth technical skills and have only a superficial understanding of their systems and their operational art. As a result of our history, there is not yet an effective Air Force space culture nor set of subcultures and this must be addressed to take the Air Force into the future. However, before one can take those steps, it is essential to understand how we got where we are today and our current state.

National Security Space: What the Heck Is It and Where In the Sam Hill Did It Come From?[12]

Understanding and embracing these cultural issues are fundamental to addressing problems and moving forward. Key events, many beyond the control of the space community, have been crucial in shaping the Air Force Space culture. Any prescription for the future must be rooted in the effects of the past on the present.

The Early Years (1950s - Early 1960s)

Since the first space launches in the 1950s, the Air Force has become the dominant space service. In the infancy of space program development in the late 1940s, 1950s, and early 1960s, the Air Force and the Army competed for this lead role. The competition, primarily focused on ballistic missile and reconnaissance satellite developments, was spurred by strong top-down direction from civilians in the Office of the Secretary of Defense (OSD) rather than by internal service proponents. Throughout the 1950s, the Eisenhower administration provided very specific, though classified, objectives for these programs. Neither the Air Force nor the Army developed military space doctrine during this period. The DoD's primary priority was ballistic missile development, leaving the administration to focus orbital space efforts on technical reconnaissance and surveillance of the Soviet Union in order to open up this closed society. A related focus of the Eisenhower administration was to protect these emerging national assets satellites by creating new international agreements aimed at developing a sanctuary from which these systems could freely operate.[13]

The Air Force pushed aggressively during this period for responsibility of the "aerospace medium" above the Earth's surface. However, with the creation of the NASA in 1958, the Air Force quickly lost its lead position in the national space program and fell to a role as the leader within DoD.[14] Also during this period, the Eisenhower administration created the National Reconnaissance Office (NRO) to, in the words of President Eisenhower, "make damn sure" any new structure would not result in Air Force control. Although the Air Force, along with the Central Intelligence Agency and Navy, had a significant role in the NRO, this step was another "vote of no confidence in the Air Force to manage spy satellites through more normal channels."[15] More importantly, the creation of the NRO "moved this most important intelligence data stream away from military operators."[16]

Despite the above trends, many Air Force space efforts, during the 1950s and 1960s, were under the guidance and direction of the NRO. In this capacity, the Air Force played key roles in Corona, the first photo-reconnaissance satellite, the Air Force Satellite Control Network (AFSCN), built to support Corona, and the Defense Meteorological Satellite Program (DMSP), built to enhance Corona mission effectiveness by better understanding cloud cover over the Eurasia landmass.[17] In 1961, an additional event occurred that would prove to have long-term consequences. Relying heavily on NRO satellites, the National Intelligence Estimate set the number of Soviet intercontinental ballistic missiles (ICBMs) at fewer than ten. This was in stark contrast to the predictions in 1957 that the Soviets were well on their way to having over five hundred ICBMs.[18] This event not only sold the political leadership on the idea of limited Air Force control of classified intelligence space programs, but also instilled the concept of these programs as critical *national strategic* assets.

Space Community Divisions Become Institutionalized: Mid 1960s - Late 1970s

The situation grew worse from the Air Force perspective, between the early 1960s and the late 1970s. During this period, the concept of space as a sanctuary for national technical means of verification of Soviet activity became dominant. Additionally, the role of the mainstream Air Force in US classified satellite programs was gradually reduced. At times the Air Force even struggled to gain access to the data from national systems.[19] The DoD, including the Air Force, also focused very heavily on the Vietnam War conflict during most of this period, further reducing service emphasis on space. Finally, during this era the Congress organized so that separate committees administered oversight of military and intelligence programs. This created a structural and funding divide between the national intelligence community and the services that still exists today.

These barriers and perceptions left the Air Force to take developmental and operational lead for systems that were perceived to be less glamorous than the intelligence, surveillance, and reconnaissance systems that would continue to be operated by the NRO. Operations of these and other satellite constellations were dubbed "force enhancement" because of their inherently supportive nature. This labeling was significant because this term came to represent satellite operations in general rather than a construct focused on missions. Recognizing their ubiquitous nature and the worldwide expectation of their availability, these systems would later be called "global utilities." Global utility systems are designed "to provide communication, environmental information, position, images, location, timing, and other services and data to global users."[20] Research and development beginning in the 1960s led to later development and operations of such programs as the global positioning system (GPS), the Defense Satellite Communications System, and the Defense Support Program (DSP). Control of DMSP and the AFSCN was transferred from the NRO to the Air Force.[21] By the end of the decade, the Air Force had become the unquestioned DoD leader in space. However, Air Force space culture was focused primarily on operating machines executing the global utility mission.

Who are We and Do We Believe Our Own Doctrine? The 1980s

With the events of the previous thirty years leaving the Air Force with a dominant position in DoD space, and with a now engrained institutional separation between military and national space programs, the Air Force began building an infrastructure designed to support the satellite missions it had been given. In 1982, the Air Force created Air Force Space Command (AFSPACECOM later AFSPC) to fulfill the institutional service role of organizing, training, and equipping to fulfill this mission.[22] Satellite operations (primarily for utilities), and eventually space launch, were moved from Air Force Systems Command to AFSPC. The battles to establish the command and then to gain control of the satellite command and control (C2) and strategic space launch missions led to a huge emphasis on these areas that continues today. Space surveillance and missile warning functions were also rolled under the new command. In the 1980s, the Air Force spent significant resources on further developing its ability to deliver these utility services. AFSPC constructed a headquarters facility and a massive satellite operations facility near Colorado Springs, Colorado.

Also, in the 1980s, largely due to civilian leadership pressures within the Reagan administration, the Air Force developed and tested an ASAT program.[23] This system, successfully tested on 13 September 1985, launched a missile from an F-15 to hit-to-kill a low-Earth satellite.[24] According to Peter Lang Hays, despite Air Force support for the program, neither DoD nor the Air Force "mounted anything near an all-out program to sell" the ASAT. It was also "remarkable how little support the program received from the Pentagon." Even more telling was the lack of support from Air Force officers. The support that did occur was mostly from OSD civilians. Furthermore, it was clear that the Air Force did not "even believe its own space control doctrine statements in Air Force Manual 1-6 and therefore did not strongly support the development of one of the types of weapons required to begin to create an actual space control capability." This trend of writing doctrine for mostly political purposes still continues today.[25] Why the lukewarm support from Air Force leadership? By the mid 1980s, the Air Force was well into the struggle to consolidate its position as the nation's leader in force enhancement. Many of the space officers working these issues had "grown-up" within an Air Force space community whose failed attempts outside the scope of its force enhancement, space surveillance, and space support functions had created a mental and political "lane" within which the Air Force should drive. This role gave AFSPC a large budget and an uncontroversial mission within which it could grow its space capabilities, as the need for them expanded over the coming years.

One other significant event of the 1980s played a major role in shaping today's space attitudes. On 28 January 1986 the space shuttle Challenger exploded slightly over a minute after launch.[26] In addition to the impact on NASA, the repercussions of the disaster were felt throughout the DoD and the Air Force. The Air Force had begun a large program to launch military and national classified payloads on the shuttle. These launches would have been out of an Air Force base in California and would have been controlled by Air Force operators at Falcon AFB, Colorado. In the preceding years Congress and the Air Force had also begun to rely heavily on the Shuttle to launch Air Force and other DoD force enhancement payloads. The Challenger disaster resulted in an immediate stand down of shuttle launches leaving the Air Force with very limited expendable launch capability to handle the large number of communications and navigation satellites then coming online.[27] The resultant feud between the Air Force and NASA over the appropriate launch policy caused an additional rift between these two major space organizations that would impact space development for years to follow. The Air Force shuttle program was mothballed. The Air Force experienced several "false starts" during this period, which at least partially were due to the lack of "clear and powerful space doctrine." Again there seemed to be a "general ambivalence over the military potential of space." And so by the end of the decade, AFSPC, NASA, and the NRO were well established in their separate and distinct "lanes."[28]

By 1989, the perspective of space within the Air Force was that of the "service provider." This perspective was almost completely dominant. Even the newly established Undergraduate Space Training (UST) program, modeled after the Air Force rated officer training program, focused almost exclusively on these broad utility type missions and enablers such as fixed site strategic space launch.[29] As the Cold War ended the Air Force, along with the rest of DoD, struggled to adjust to a new world order. For the space community, this meant dealing with an emerging growth in consortium and commercial systems that would drastically change the equation that had previously existed between the US and the Soviet Union. During the Cold War, Air Force Space emphasized providing these utilities to worldwide US defense, and national level users, in support of the bi-polar struggle. The result was a set of very expensive systems that were long-lived, but in many cases rapidly outdated. Also, the events of the previous three decades had left an impression with almost all sides of the space community, DoD leadership, and the political leadership establishment, that space was inherently a strategic asset.[30] That, along with the needs driven by the Cold War, left the Air Force with a set of very large, expensive satellites that required a similarly expensive infrastructure to produce, launch, and operate them.

Space Utilities Make a Difference, But There's Nothing New Under the Sun: The 1990s

The dawn of the 1990s saw AFSPC maturing as a standalone organization. With DoD responsibility for positioning and timing satellites, missile warning satellites, communications satellites, and weather satellites, the Air Force was well established as the national service provider and as a voice in the national space debate. Desert Storm, in 1991, had shown that utilities provided from space were critical to conventional warfighting.[31] However, as time elapsed in the 1990s the space world began to change rapidly. Purely commercial systems for remote sensing and communications were becoming very prevalent. GPS navigation and timing had become available to everyone, and the Europeans were talking about a competing system. By the end of the decade, the Air Force had made little progress on fielding a set of modern boosters or modern communication or navigation satellites. These efforts had continued to slip due to developmental delays and arguments about requirements. The Air Force remained primarily focused on force enhancement as its primary "space mission," and the approach remained one of building highly redundant, large systems with long development and operational life cycles. This focus forced the Air Force to place the vast majority of its resources into a very limited number of systems that, due to long development cycles, faced a constant struggle to be technologically relevant throughout their operational life. This left very few resources available for other missions and the development of new technologies that would be needed to break out of this cycle of big satellites with relatively less capability and long development and procurement periods, as compared to commercial systems.

Another series of events in the 1990s had a significant impact on the approach the Air Force would take with respect to space. Inheriting its model from the NRO, the Air Force originally adopted a model that grew its space leaders from backgrounds that included experience and familiarity with research, development, acquisition, test and evaluation, and operations. In addition, AFSPC originally required its space operators to be officers degreed in a technical field.[32] The need for deep technical skills was seen as a fundamental requirement to not only develop and acquire space capabilities, but to operate and employ them effectively as well. However, this changed in the early 1990s after a series of decisions that were driven more by policy and resource constraints than by operational need. The three fundamental policy drivers were the drive to "normalize" space operations, the final transition of the space launch and satellite operations missions from Air Force Systems Command (AFSC) to AFSPC, and the merger of the ICBM and space operations career fields.

The effort to "normalize space" had begun in the 1980s, but became AFSPC's mantra after Desert Storm. After tasting the success of integrating space at the operational and tactical levels of war, the command set a course to operationalize its military space capabilities. While the goal of better warfighter integration was appropriate, internal AFSPC execution had serious unintended consequences.

The discussion regarding the transfer of responsibility for space launch and satellite operations from the AFSC to AFSPC started in the 1980s, but culminated in the early 1990s. Up to this point, the bulk of Air Force space experience was split between two Air Force communities with two separate Air Force specialty codes (AFSCs)—the engineers and the space operators. The Air Force's largest cadre of space experts resided in System Command's large core of space-experienced officers with engineer AFSCs. The career paths of these officers included both space acquisition and operations jobs in both the Air Force and the NRO. AFSPC's officers with the space operations AFSC had their genesis in space missions originally owned by Strategic Air Command and included DMSP weather satellite operations, many elements of the integrated tactical warning and attack assessment infrastructure including DSP satellites and ground based sensors, and the space surveillance network.[33]

The merger of the ICBM and space operations career fields was also a decision many felt made sense in the early 1990s. After a short organizational alignment under Air Combat Command after the command was formed in 1992, responsibility for ICBMs was transferred to AFSPC on 1 July 1993. This transfer brought Twentieth Air Force's six missile wings, although plans were in place to cut back to three wings due to strategic arms reductions, and one test and training wing under AFSPC leadership. In addition to more than doubling the size of the command, the ICBM community brought a homogeneous culture to AFSPC that was rooted in the skills and approaches required for the safe and effective C2 of nuclear forces.[34]

The above three policy decisions drove countless changes to the Air Force space culture and recent developments are beginning to indicate that many of them had unintended consequences. Several are worth mentioning. The command no longer wanted officers with engineering AFSCs in leadership positions because those AFSCs belonged to Systems Command and they did not fit the model for normalized space operations. We did not "need" space operators with technical degrees because normalized space launch and satellite operations "could be done by any officer and in many cases by enlisted personnel." This policy decision was also needed in order to make these new AFSPC jobs available to the thousands of ICBM officers who were not accessed into the Air Force with technical degrees. Within a very short period of time, a wholesale change occurred in the manning of our spacelift and satellite operations units and in the operational practices within those missions. The previous procedures and practices began to change to a single set of higher headquarter instructions that governed all nuclear and space operations missions. Procedures and training were changed to place heavy emphasis on standardized procedures and reliance on contracted engineering expertise during launch phase and anomaly resolution. It was no longer necessary to have a solid foundation in orbital mechanics, nor in the technical functions of the satellite.[35] An increasingly cumbersome and bureaucratic environment, focused on compliance with instructions and rules, left little room for creative application or innovation.

However, these changes in procedures and operator education did not result in critical failures in AFSPC satellite operations. The nature of the mission's flown by the vast majority of AFSPC operators—force enhancement, where satellites are predominately in geosynchronous and semi-synchronous orbits—required very little operator interaction. These changes in procedures limited the hands-on interaction and creativity required for more robust and intensive satellite operations. By the end of the decade AFSPC had "raised" a generation of company and junior field grade space operations officers who did not understand the technical or the tactical art of space operations. Unlike operators within the NRO, many AFSPC operators have experience only in virtually static operations. In these operations, human interaction with the satellite is relatively infrequent, highly prescribed, and planned well in advance.[36] In addition, it fosters a focus on operating the machine, rather than the delivery of effects to the warfighter from the machine.

One specific change in educational approach embodies the significance of changes in this area. In the late 1990s the Air Force cancelled its undergraduate course for officers entering the career field. The original UST course included courses on physics, orbital mechanics, space history, and relatively in-depth studies on the various space systems. The course required a basic technical academic background.[37] UST was replaced by a shorter, less technical, survey-type course. The emphasis in accession training became one of creating the necessary skills to perform in a specific operator position. Emphasis was on producing operators as rapidly as possible who could reliably execute a narrow set of defined procedures. Thus new space operations officers became arguably more like technicians who focused more on following procedures than on developing operational art to enhance mission effectiveness. This training over education model limited technical depth and operational art development.[38]

Finally, the Air Force made uniform and other changes in an attempt to create an "operator mentality" within the space community similar to that held in the rated community.[39] During the formative years of 1910-1940, the Army Air Corps developed a degree of dedication that drove them to develop and promote applications of airpower, even at the risk of career detriment. This sense of what it meant to be "airmen" arguably bordered on elitism, and still exists today.[40] In contrast, such a self-view among space operators of what it means to be "spacemen" has not developed as a common firmly held belief among space operators.

Icarus or Mitchell? Does it Matter? 2000 and Beyond

As the new millennium dawned, the Air Force was focused on new large boosters and better application of force enhancement systems to support users.[41] New satellite systems under development tended to be more capable, one-for-one replacements for systems developed and fielded in the 1970s and 1980s. Many of these systems were not scheduled to reach final operational capability for another fifteen to twenty years. The space operator corps was non-technical with no in-depth understanding of how satellites "fly," or of the technical intricacies of satellite operations and missions. The Air Force also endured public criticism for its space activities and three different commissions were actively reviewing different aspects of how the national security space program functioned.[42] Also in 2000, the Air Force published a white paper on Air and Space Integration that dubiously declared "that air and space form a single 'seamless operational medium' for the exercise of military power."[43] This provided even more fodder for those anxious to criticize the Air Force position on space.[44]

While the Space Commission, chaired by Donald Rumsfeld, recommended positive changes, these changes were mostly in the areas of high-level organizational modifications and individual responsibilities.[45] However, the Commission also made key recommendations aimed at repairing much of the damage done to Air Force space culture in the previous decades. Though the Air Force implemented some aspects of the Commission's recommendations in this area, several key elements were rejected out of hand during Air Force implementation. The Air Force continued ICBM and space operations as a common career specialty. They did not create new AFSCs or career paths integrating the space engineer and space operations AFSCs. The AFSPC commander was not given functional authority over all personnel within every space professional-designated career field.[46] However, AFSPC/CC's recent initiative to institutionalize his role as the Space Professional Functional Authority's in Space Professionals' career management is a positive step toward ensuring needed space expertise across all AFSCs. Time will tell if it lasts long enough to have a lasting impact.

After a short experiment with mission-focused teams at Headquarters AFSPC, the command returned to a functional structure and then reorganized into the numbered "A-Staff" structure used originally by the Army and now employed throughout much of DoD. Under these models, the power of individual functional areas grew at the expense of broader or more mission-focused groups. Functional groups tended to act like functional tribes, carefully guarding their "lane in the road." This made broad-based initiatives very difficult to push through for approval due to the dozens of "stakeholders" with de facto veto authority. As of 2007, despite the touted space support to theater, the strategic mindset remains prevalent. The Air Force continues to lag in producing new and novel capabilities including those involving space power and direct theater support. The Air Force community has an overriding anti-culture culture that is support focused.

1950s and Early 1960s	• Establishes civilian lead of National Security Space program • Highest interest programs outside Air Force structure • Instilled perception of space systems as critical national strategic assets
Mid 1960s-Late 1970s	• Space Control suppressed by presidential focus on international agreements: Sanctuary School dominates • Air Force becomes DoD space leader • Big successes in large, expensive, long duration systems optimized for Strategic users
1980s	• Space systems well engrained as inherently strategic • Perception of Space within Air Force as service/utility provider dominant • Officer training focused almost exclusively on utility systems and infrastructure produces young officers with that focus • UST established—modeled after UPT, officers from technical degree programs. Heavy emphasis on physics, orbital mechanics and system operations. • Driven by civilians in Reagan administration Air Force develops and tests F-15 ASAT; "little support from the Pentagon", even from Air Force officers
1990s	• Air Force remains primarily focused on services/utilities • Approach remains highly redundant, large systems with long development and ops life cycles--consume vast majority of available resources leaving little room for systems and techniques optimized for tactical users and uses • ICBMs integrated into AFSPC • Satellite control and space launch missions transferred from AFSC to AFSPC • Normalization: limited hands on interaction and emphasized the strategic nature of sat ops (risk avoidance over innovation) • Need for Air Force space engineers in AFSPC heavily de-emphasized…acquisition and engineering career paths become firmly linked to AFSC/AFMC • Air Force space operations officers no longer require technical degrees or receive training with an emphasis on the engineering, science and art of space operations. UST disestablished. Accession training focused heavily on specific job performance not on developing space operators. This training over education model limited technical depth and operational art development. • Air Force space culture is fragmented and watered down. • Intellectual framework and organizational structure created around missions the Air Force obtained from other agencies not around bottom up examination of missions to be accomplished and associated operational art.
2000s	• Slow response to rest-of-world and potential theater oriented space applications • After initial steps, Space Commission recommendations generally not implemented • Air Force Space culture dominated by a Strategic Nuclear mindset. Further strengthens risk avoidance and strict adherence to procedure versus tactical mission focus. • AFSPC is culturally support focused with an anti-culture culture. Its officers have only a surface level understanding of their operational art and lack deep technical skills in specific missions. • No intellectual framework exists to underpin needed professional or capability development. • Functional fiefdoms and overly bureaucratic hierarchical processes make broad or mission focused innovation difficult.

Table 1. Key events and outcome observations affecting Air Force Space culture.

This is due, in part, to the generalist nature of the career field and the lack of development within well-defined areas related to specific missions. Officers are moved from one mission area to another, limiting development of in-depth expertise in any specific area. Officers do not develop the knowledge of theory and operational art that are critical to long lasting cultural norms.[47] This, combined with procedure-focused education and training and similarly focused operations models, inhibits the development of a "critical mass" of space professionals who posses the ability to bring the types of expertise to bear that are critical for leading innovation in techniques and capabilities.

Interpreting History

The table to the left summarizes and lists those critical events that drove today's Air Force space culture. It also lists the key outcomes that must be understood and accepted before a strategy for positive changes can be implemented.

Where Are We Now? Observations and Foundational Findings

The cultural development of Air Force Space has been largely driven by forces other than internally developed theory, strategy, and doctrine. The observations from Table 1 offer a guide to the key challenges facing the space community today. Part II of this paper will focus on describing those challenges in order to ascertain the root causes of weak areas. It will also focus on defining recommendations intended to offer tailored prescriptions. These observations are grouped to form four focus areas for diagnosis and discussion. Part II will further develop these findings and will lay out specific recommendations to address each focus area:

Focus Area 1: Recommended 2025 Capability Goals

Primary Finding: 2025 space capabilities must include the ability to establish space superiority as needed to enable US freedom of action; assured and robust strategic global utilities (services); and new capabilities that deliver a flexible range of globally responsive, precise, tailorable combat support and combat effects focused on the needs of combatant commanders. All of these capabilities must be fully integrated into the global information grid and merged onto the battlefield with manned and unmanned systems operating in all domains.

Focus Area 2: The Intellectual Framework—It Drives Everything and It Must be Right

Primary Finding: Space is a medium (domain), not a mission. The intellectual framework for space power must be driven by the inherent attributes and principles of space power. The current framework is organized around who owns what and unnatural groupings of dissimilar missions. The current mindset is heavily slanted to utility/service areas. Warfighting principles and terminology to describe and guide the proper use of space forces in military operations are essential for long-term continuity of action and capability growth. To date they have not been developed. The current organizing principles drive the ineffective approaches to how we are organized, how we define and manage our work force, what types of skills sets are needed by our people, and where we spend our money. The Air Force has adopted a one size fits all model for space operations, training, and evaluation for a set of fundamentally different missions. In many cases, this model negatively impacts mission accomplishment.

Focus Area 3: People: Nurturing Our Most Important Resource

Primary Finding: The majority of today's space operations officers, at all levels, do not have the needed technical background, training, and educational and operational experiences required to foster innovative growth and warfighting impact needed in the future. This shortfall is most acute in the current generation of Air Force Space company grade and junior field grade officers who are on the verge of leading our community. Inadequate educational guidelines and goals combined with procedure-focused training structures leave the community without well prepared, capable space professionals. The current model of growing space professionals should be modified. The lack of mission driven, directly managed selection, and professional growth models within mission areas produces officers without the necessary background to fill the growing number of challenging leadership and technical positions.

Focus Area 4: Processes and Programs—Making it Happen

Primary Finding: Air Force space organization, management, processes, and programs are fractured, overly bureaucratic, and often underachieving—there are few in-depth institutional competencies, little focus on developing fundamentally new capabilities, and a limited ability to act in a flexible or responsive manner. The communities' core processes are less effective than the demanding security environment requires. At times they are too cumbersome, hierarchical, and bureaucratic. Past procurement problems with replacement constellations and the lack of sustained focus on development of innovative new concepts has limited truly "new" responsive capabilities.

Notes:

[1] Staff Sergeant Monique Randolph, "Senior Leaders Testify About Air Force Space Program," *Air Force News*, 5 April 2007.

[2] This date was selected to represent three Future Years Defense Plans (FYDPs)-the six year DoD programming cycles. In the authors' opinion three cycles is sufficient time for changes to be implemented and resultant new and innovative capabilities to be introduced in order to significantly alter the contributions of space forces to any future scenarios.

[3] Wang Hucheng: "The US Military's 'Soft Ribs' and Strategic Weaknesses," *Liaowang*, issue 27, XINHUA Hong Kong Service, 5 July 2000.

[4] David Lague, "An Aircraft Carrier For China?" *International Herald Tribune*, 30 January 2006, http://www.iht.com/articles/2006/01/30/business/carrier.php. (Accessed on 26 June 2007).

[5] Max Boot, *War Made New* (New York: Gotham Books, 2006), 427.

[6] 2007 China Military Power Report Talking Points. The key points from this report that are relevant to the paper's future China scenario are manifold. China has embarked on a long-term, comprehensive expansion to fight and win what it calls "local war under the conditions of informatization," which emphasizes speed, precision, mobility, and the role of information technology as a force multiplier. In particular, China is acquiring military capabilities that could be disruptive to regional stability, including at least 10 varieties of ballistic missiles deployed or in development, five active submarine programs, at least two land attack cruise missile systems, 12 types of anti-ship cruise missiles, advanced surface ships, fighter and multi-role aircraft, space and counter-space capabilities (e.g., direct ascent ASAT program), and information warfare. China has not renounced the possibility of using force to reunify Taiwan. Lastly, China is investing heavily in qualitative and quantitative improvements to its strategic forces. The introduction of new road-mobile, solid propellant intercontinental ballistic missiles and a new submarine launched ballistic missile will give China's leaders options they did not previously have. China's air and naval force improvements are scoped for operations beyond Taiwan. Counterspace and information warfare programs appear designed to deny access to space and cyber-space, as well. China's fleet is gaining familiarity with open-ocean operations and conducting maritime exercises outside Chinese waters. The PLA Air Force is developing airborne early warning and control, and aerial refueling programs, extending the potential range of its strike forces far from China's shores. China's C4ISR includes space-based and over-the horizon sensors, potentially providing hemispheric coverage. China's strategic forces modernization (nuclear, space/counterspace, and computer network operations) can have a global impact.

[7] *Annual Report to Congress, Military Power of the People's Republic of China*, Office of the Secretary of Defense, 2006, http://www.globalsecurity.org/military/library/report/2006/2006-prc-military-power04.htm. (Accessed on 26 June 2007).

[8] Many articles and books discuss the growing capability of the People's Liberation Army. *Chinese Military Power: Report of an Independent Task Force,* (New York: Council on Foreign Relations Press, 2003), provides an excellent summary and a list of key indicators to gauge Chinese military modernization.

[9] James C. Mulvenon, Murray Scot Tanner, Michael S. Chase, David Frelinger, David C. Gompert, Martic C. Libicki, Kevin L. Pollpeter, *Chinese Responses to US Military Transformation and Implications for the Department of Defense*, (Santa Monica, CA: RAND, 2006). Discusses Chinese perspectives on US military dominance and specific activities aimed at countering US capabilities. 60-76 discuss counter naval and counterspace strategies. The Chinese have called GPS the "Soft Rib of the High-Technology Battlefield."

[10] Ibid.

[11] The Airman's Creed exemplifies the Air Force warrior ethos. While countless space professionals have answered their nation's call to deploy and fight in Global War on Terror, this section of the paper is aimed at growing that same warrior culture within the space mission area.

[12] Some of the historical descriptions here are taken directly from *A Space Force? Not Now*, A paper written by then Major Crawford at Army Command and General Staff College. However, the original sources are referenced.

[13] Peter Lang Hays, *Struggling Towards Space Doctrine: US Military Space Plans, Programs, and Perspectives During the Cold War*, (Ann Arbor: UMI, 1994), 61-178.

[14] Ibid.

[15] Jeffrey T. Richelson, *America's Secret Eyes in Space: The US Keyhole Spy Satellite Program,* (New York: Harper and Row, 1990), 46-47.

[16] Hays, *Struggling Towards Space Doctrine,* 181.

[17] Steven R. Strom and George Iwanaga, "Overview and History of the Defense Meteorological Satellite Program," *Crosslink Magazine*, (Winter 2005), http://www.aero.org/publications/crosslink/winter2005/02.html (Accessed on 28 May 2007).

[18] Hays, *Struggling Towards Space Doctrine,* 179-183.

[19] Ibid., 183-270.

[20] Lt Gen Bruce Carlson, "Protecting Global Utilities: Safeguarding the Next Millenium's Space-Based Public Services," *Aerospace Power Journal* 15, no. 2. (Summer 2000), 37-41.

[21] Steven R. Strom and George Iwanaga, "Overview and History."

[22] David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership*, rev. ed. (Maxwell AFB, Alabama: Air University Press, 1998), 202-208.

[23] Then Second Lieutenant McLaughlin graduated from Air Training Command's Space 2001 Technical Training Course in August 1983.

[24] Then First Lieutenant McLaughlin was on duty as a chief Satellite Officer in Cheyenne Mountain's Space Defense Operations Center (SPADOC) during the successful test.

[25] Hays, *Struggling Towards Space Doctrine,* 422-430. See later discussion in this article on Air Force doctrine and attempts to declare Air and Space as a seamless medium. The important point is not the current doctrinal stance but rather that the continued attempts by the Air Force to keep and gain control of space within DoD have shaped the culture of the Air Force Space community.

[26] Nicholas Booth, *The Encyclopedia of Space* (New York: Mallard Press, 1990), 42.

[27] Ibid, 76.

[28] Hays, *Struggling Towards Space Doctrine,* 343.

[29] Then Second Lieutenant Crawford graduated from UST in April 1989.

[30] Although the definitions of the terms strategic and tactical have changed over the years, the key point is that the developers and operators of space systems viewed their primary customers as national level users and thus acted to optimize for strategic effect. Today when new requirements are written and systems are designed one is often faced with "forks in the road" where the path is one of either optimizing for broader and longer duration capabilities or more specific rapidly available capabilities. Although the recent Operational Responsive Space initiative is a step toward more tactically effective systems the strategic mindset—rhetoric aside—is still predominant.

[31] Benjamin S. Lambeth, "The Synergy of Air and Space," *Aerospace Power Journal* 12, no. 2 (Summer 1998), 4-6.

[32] Undergraduate Degrees in engineering, mathematics, or physics were required.

[33] K. McLaughlin, "Military Space Culture," background paper, in Report of the Commission to Assess United States National Security Space Management and Organization, Washington, DC, 11 January 2001, 13-18.

[34] McLaughlin, "Military Space Culture," 13-18.

[35] Commission to Assess United States National Security Space Management and Organization, report, Washington, DC, 11 January 2001, 11.

[36] The authors were space operators in AFSPC during this period.

[37] McLaughlin, "Military Space Culture," 13-18.

[38] From 2004 to 2006 Colonels McLaughlin and Crawford while at the 50^{th} Space Wing observed this phenomenon directly. During this time they worked on an AFSPC supported effort to reestablish more broad based and technically in-depth education and training for both accessions and current satellite operators.

[39] In the mid 1990s, the Space operator uniform was changed to the "blue bag" used by missileers in SAC. In the late 90s, space operators were issued leather jackets like those worn by rated officers. In 2001, the space operator uniform was changed to the Nomex "bag" worn by rated officers; Lambeth, 4-14, provides a detailed discussion of the many starts and stops in the struggle within the space community to create a perception of relevance and on the part of the Air Force to create, within the space profession, an operator mentality.

[40] David R. Mets, *The Air Campaign: John Warden and the Classical Airpower Theorists* (Maxwell AFB: Air University Press, April 1999), 41-45.

[41] The highly publicized success of the Joint Direct Attack Munition (JDAM) is just one example of the fruits of this effort. The last 10 years in particular have seen a marked improvement in providing space utilities in ways that allow smarter more effective application by users around the world.

[42] Three commissions: The Independent Commission on the National Imagery and Mapping Agency (NIMA); The National Commission for the Review of the National Reconnaissance Office (NRO); The Commission to Assess United States National Security Space Management and Organization (previously referenced).

[43] "The Aerospace Force: Defending America in the 21^{st} Century," Air Force White Paper, May 1999, reprinted in *Air Force Magazine* 83, no. 7 (July 2000).

[44] Interview with Senator Robert Smith, New Hampshire, reprinted in *Air Force Magazine* 83, no. 7 (July 2000). This is just one example. Others continue to levy similar criticisms.

[45] Secretary of Defense, Donald Rumsfeld, Memorandum, 18 October 2001. This memorandum contains the SECDEF's review of the Space Commission report and outlines DoD actions that will be taken in response. Colonel McLaughlin was a member of the commission staff.

[46] As of 12 July 2007, Air Force officers from the 13S, 61S/62E/63A, 14N, and 33S career fields and enlisted from the 1C6 career field fall under the space professional umbrella. Additional career fields are currently under consideration, but not yet approved, AFSPC/A1FX (SPMO).

[47] Commission, 19-20.

Col J. Kevin McLaughlin (BS, General Studies, USAFA; MS, Space Systems Management, Webster University) is commander of Space and Missile Systems Center, Space Development and Test Wing, Kirtland AFB, New Mexico. The wing's mission is to develop, test, and evaluate Air Force space systems, execute advanced space development and demonstration projects, and rapidly transition capabilities to the warfighter.

Colonel McLaughlin was commissioned through the US Air Force Academy in May 1983. He has served in a variety of space operations and staff positions. His experience in space operations includes space control; space launch; satellite positioning, navigation and timing; and satellite command and control. His operational assignments include commander, 50^{th} Operations Group; commander, 2^{nd} Space Operations Squadron; and chief, Current Operations Flight, 45^{th} Operations Support Squadron; deputy chief standardization and evaluation, 45^{th} Operations Group; chief, Launch Operations and Titan IV Launch Controller, Titan Combined Task Force; and chief satellite officer, Space Defense Operations Center, Cheyenne Mountain Complex.

Colonel McLaughlin has served in staff assignments at the Office of the Secretary of Defense, Headquarters Air Force, the National Reconnaissance Office, and Headquarters AFSPC. He also served as a professional staff member on the Commission to Assess National Security Space Management and Organization chaired by Secretary of Defense Donald Rumsfeld.

Col Chris D. Crawford (BS, Statistical Mathematics, University of Alabama; MBA, University of West Florida; National Security Fellow, John F. Kennedy School of Government, Harvard University) is commander, 21^{st} Operations Group, 21^{st} Space Wing, Peterson AFB, Colorado. He is responsible for the readiness and tactical execution of AFSPC's largest operations group with 16 units located across the world. The colonel leads 1,200 people who defend the US through exploitation of space by providing missile warning and space control to the National Military Command Center, North American Aerospace Defense Command, unified combatant commanders, and combat forces.

Colonel Crawford has served in various duties including as a satellite operator, as a space surveillance crew commander, and as chief of Standardization and Evaluation. He served on the AFSPC staff as chief of Space Control Mission Concepts and on the Headquarters Air Force Staff as chief of Space Control Plans and Operations, executive officer, and deputy chief of the Space and Reconnaissance Division. Colonel Crawford also served in National Security Space operations as director of Missions and chief, Operations and Engineering. While deployed he served as Space and Information operations officer to the director of the Coalition Forces Land Component Command, Air Component Coordination Element during Operation Iraqi Freedom. He also commanded the 50^{th} Operations Support Squadron, Schriever AFB, Colorado.

"Just a Matter of Time"[1]
How and Why the US Air Force Established a Space Command

Dr. Rick W. Sturdevant
Deputy Command Historian
HQ AFSPC History Office

Twenty-five years ago, on a beautiful September morning at Peterson Air Force Base (AFB) in Colorado Springs, Colorado, the United States Air Force (USAF) activated a major command for space operations. The reasons for Space Command's establishment lay in issues, decisions, and events that stretched back at least a decade—back to the last years of the Vietnam War, to budget cuts and military belt tightening, and to subsequent efforts to revitalize American military preparedness. During this period prototypical military satellite systems for meteorology, communications, and early warning began to mature operationally. A new system for delivering precise navigation, positioning, and timing signals from space—the global positioning system (GPS)—appeared on the drawing board, and plans for a new launch system—the Space Transportation System (STS) or Shuttle—significantly influenced how future military satellites would achieve orbit. It was a time when the strategic threat from the world's only other superpower, the Soviet Union, still loomed large in the minds of political and military leaders and, also, a time when policymakers and planners foresaw more extensive tactical applications for strategic satellite systems.

As military space systems matured in the early 1970s, the Air Force assigned operational responsibility for satellites to different commands, depending on which organization had the greatest functional need for a particular space-based capability. That dispersal of systems made it difficult to coordinate either requirements or operational concepts from a "total system" perspective, and it forced the Air Staff to perform programmatic tasks that belonged more properly at a major-command level. Furthermore, as military space systems became more sophisticated, some possessed multiple capabilities that made it increasingly difficult to assign them to a specific command based on function. Summarizing the situation in a 1977 *Air University Review* article, Col Morgan Sanborn wrote, "The point is that space has become an amalgam of systems and users.… The need for a separate space command within the Air Force … seems obvious."[2] Without such a singular organization to oversee the employment of space capabilities, use of that medium for enhancement of terrestrial forces would remain limited.

Various studies and pronouncements during the late 1970s pointed toward the need to change fundamentally how the Air Force was organized for space operations. Both the technically oriented "New Horizons II" study chaired by Brig Gen David D. Bradburn in 1975 and the comprehensive "Future Air Force Space Policy and Objectives" study by HQ USAF/XO early in 1977 blamed the service's inefficient utilization of space assets on an inadequate understanding of capabilities and lack of clearly articulated goals for the operational use of space. The latter study included a large matrix listing systems across the top and functions down the left side, with color coding for each organization involved in each of the functions for each of the systems. Because of the many colors associated with the different functions and systems, the matrix became known as the "Navaho Blanket" or chart. Its depiction of just how complex and confusing space development and operations had become organizationally caused General Russell Elliott Dougherty, Strategic Air Command commander in chief, to say in April 1977 that something really needed to be done about the situation.[3]

As for the difficulty of determining where to assign space systems with multiple capabilities, the reusable Space Shuttle provided a case in point. Because of the Shuttle's advertised prospects for drastically reducing launch and operational costs compared to expendable boosters, the Air Force, acting as Department of Defense (DoD) executive agent for STS, signed an agreement with NASA in February 1970 to ensure continuing review of the Shuttle's ability to meet both DoD and NASA requirements. In 1974, two years after President Richard Nixon formally approved NASA's development of the Shuttle, at least four Air Force major commands—Strategic Air Command (SAC), Aerospace Defense

An Aerospace Defense Command planning team helped prepare the April 1982 briefing to the Air Staff on organizational options for space. The team, subsequently dubbed "Founders (7)," consisted of (left to right): Brig Gen Carl N. Beer, DCS/Plans; Col Richard P. MacLeod, chief of staff; Maj Gen Bruce K. Brown, assistant vice commander; Gen James V. Hartinger, commander in chief (holding the slide that proposed a separate operational command for space); Lt Col Samuel C. Beamer, chief of Plans and Policy Division; Col Thomas S. Moorman, Jr., director of Commander's Group; and Col G. Wesley Clark, director of Space.

Command (ADCOM), Air Force Systems Command (AFSC), and Military Airlift Command (MAC)—contended they would be the logical choice to operate the system for military purposes.[4]

The case for ADCOM overseeing military Shuttle operations seemed reasonable, given previous assignments of space-related missions to that particular command. In July 1961, it had activated the 9th Aerospace Defense Division to handle Space Detection and Tracking System, Ballistic Missile Early Warning System, and Missile Defense Alarm System operations. On 15 November 1963, the 10th Aerospace Defense Squadron activated to perform Program 437 anti-satellite operations. Beginning in 1967, that unit also launched Defense Meteorological Satellite Program (DMSP) payloads from Vandenberg AFB, California, on Thor boosters. Then, in July 1968, the command formed the 14th Aerospace Force with separate wings for space surveillance and early warning. When the United States began launching Defense Support Program (DSP) early-warning satellites in 1970, ADCOM gained operational responsibility.[5] As ADCOM Commander General Lucius D. Clay, Jr., explained in a 23 April 1974 letter to US Air Force Chief of Staff General George S. Brown, the "breadth and magnitude" of his command's operational space activities surpassed all other DoD agencies, making ADCOM the "logical" choice for DoD Shuttle operations.[6]

General Clay's letter, apparently reinforced by one in September 1974 from the STS System Program Office director, who observed the Air Force already was three years late in designating an STS operating command, prompted the US Air Force chief of staff to ask all major commands in a 5 October 1974 letter whether there should be an operational space organization and, if so, whether it should be an existing command. In response on 25 November 1974, General Clay dispatched a ten-page paper explaining why ADCOM was the best organization for "incorporating the DoD operational viewpoint into the STS development program" and for providing "an operational environment where its flexibility can be exploited and translated into military benefits."[7] The results of this poll proved inconclusive. Uncertainties regarding approval of a new Air Force space policy and an incomplete definition of the NASA-DoD Shuttle operational relationship rendered more difficult any decision about which Air Force command would be responsible for Shuttle operations. Despite a further appeal on behalf of ADCOM from its new commander, General Daniel "Chappie" James, Jr., in April 1977, the issue remained unresolved.[8]

Whether DoD required a Shuttle Operations and Planning Complex (SOPC) separate from NASA's Johnson Space Center and, if needed, where the SOPC should be located ultimately influenced the decision to establish a separate space command. Although an October 1978 program management directive said DoD Shuttle operations would be conducted in a controlled mode at Johnson Space Center, Texas, a May 1979 Secretary of the Air Force memorandum asserted the service stood a better chance of obtaining funds from Congress for a Satellite Operations Center (SOC) if it combined control centers—GPS, SOPC, and SOC—to form a new Consolidated Space Operations Center (CSOC). A June 1979 site-survey briefing introduced the concept of a "hypothetical site east of Peterson AFB" near Colorado Springs for the CSOC, and a December 1979 final report identified the Colorado Springs site as the preferred location for the new CSOC. By the end of September 1980, the Air Force had completed the Environmental Impact Statement and land acquisition for situating CSOC facilities east of Colorado Springs, but a request by the New Mexico congressional delegation for review of the site-selection process and criteria delayed finalization of the site decision until 17 March 1981.[9]

Meanwhile, unbeknownst to General James, US Air Force Chief of Staff General David C. Jones chartered a small, "very close hold" group chaired by the Air Staff's Brig Gen James Sutherland Creedon to study how the service might eliminate ADCOM and North American Aerospace Defense Command (NORAD) to achieve greater resource—i.e., manpower and money—efficiencies and, simultaneously, streamline its overall structure at the major-command level. The April 1977 Creedon study concluded that international political considerations made doing away with NORAD unrealistic, but it recommended closer scrutiny of ADCOM functions and organization.[10]

Acting on that recommendation, General Jones formed a second committee with less than a dozen members who were, according to one participant, "ensconsed" in a room next to General Jones' office in the Pentagon. Headed by Assistant Vice Chief of Staff Lt Gen Wilbur L. "Bill" Creech, with Brig Gen Robert T. Herres as his very active deputy and Col Harold W. "Pete" Todd as the primary action officer, the group worked "diligently five days a week … for several months" to identify the maximum number of ADCOM functions that could be retained and accomplished with the least resources. Known familiarly as the "Green Book Study" and, more formally, as the "Proposal for a Reorganization of USAF Air Defense and Space Surveillance/Warning Resources," the committee's final report recommended eliminating ADCOM, with air-defense assets going to Tactical Air Command (TAC) and space surveillance and early warning to SAC.[11]

Not surprisingly, ADCOM senior leaders—especially Gen-

Breaking ground for the Consolidated Space Operations Center at Falcon (now Schriever) AFB, Colorado Springs, 17 May 1983. Participants included (left to right): Leon Young, vice mayor of Colorado Springs; Terry Harris, El Paso County commissioner; Gen James Hartinger, commander of Space Command; Lt Gen Forrest McCartney, commander of Space Division and vice commander of Space Command; Chuck Brown, El Paso County commissioner; and Bob Prevost, vice president of Schmidt Tiago Construction Company.

eral James, his vice commander in chief and former deputy for plans Maj Gen William C. Burrows, and his deputy for operations Maj Gen Bruce K. Brown—disagreed vigorously with that proposal. On 18 October 1977, General James sent an extraordinary eight-page letter to US Air Force Chief of Staff General Timothy C. Jones. The letter began, "I have strong objections to the approach, logic, appropriateness, rationale, adequacy, and accuracy of the study proposing reorganization of US strategic defense forces."[12] General James, who had suffered a heart attack and lay in a hospital bed at the USAF Academy, campaigned for an alternative outcome, one in which ADCOM would be the "foundation for current and future operational management of expanding USAF space operations."[13] General James E. Hill, SAC vice commander in chief, replaced General James as ADCOM commander on 6 December 1977.

A few weeks later, in the war room at the Chidlaw Building near downtown Colorado Springs, the ADCOM staff presented to a general-officer review group chaired by new SAC Commander in Chief General Richard H. Ellis and ADCOM Commander General Hill a briefing titled "Potential Pitfalls in the Reorganization of Space Surveillance and Warning Assets." At the conclusion of the presentation, General Ellis stated, "I don't see any compelling reasons why it won't work," but he asked if anyone had "valid concerns" about transferring those assets from ADCOM to SAC. Only ADCOM Vice Commander in Chief Major General Burrows objected. He warned poignantly, but fruitlessly, that dissolution of ADCOM was ill-advised and probably would not withstand the test of time.[14]

Some die-hards on the ADCOM headquarters staff persisted in efforts to convince General Hill that his organization ought to survive as the nucleus for a future operational space command. When the group finally managed to present their position to the commander, General Brown introduced it as the "Dead Horse Briefing" because, as he explained, "You don't have to look into a dead horse's eyes to tell if he died." Despite the die-hards' justifiable pessimism, that briefing and subsequent personal intervention by then Lt Col Earl S. Van Inwegen, an ADCOM planner who had participated in the Creech study and in drafting General James' letter of opposition, caused General Hill to change his mind concerning the command's disestablishment.[15]

During summer and early autumn 1978, a flurry of activity fueled the die-hards' hope that reorganization of ADCOM would result in a space command. Speaking at an Air Force Academy Space Seminar in August, Maj Gen Hoyt S. Vandenberg, Jr., HQ USAF deputy chief of staff for operations, urged adoption of a more operational perspective on space systems and "perhaps a space command." An article in *Air University Review* by two lecturers, Lt Col Charles H. MacGregor and Maj Lee H. Livingston, charged that most of their fellow instructors exhibited a "professional parochialism" that favored airplanes and relegated space systems to the realm of "flashy gadgetry." Bemoaning the absence of a single Air Force organization primarily responsible for space operations, they believed only ADCOM possessed sufficient familiarity with space systems to support future operational capabilities. Under Secretary of the Air Force Hans Mark, on 7 August 1978, told Secretary of the Air Force John C. Stetson he concurred with plans to "abolish" ADCOM as a major command but recommended delaying the transfer to SAC of "space surveillance and missile warning equipment, including all of the satellite systems currently operated by ADCOM" until the implications could be studied more carefully. In October 1978, General Hill appealed to his fellow four-star generals at the Corona Pine meeting for retention of ADCOM, with its designation as the operator of Air Force space systems.[16]

Despite the die-hards' best efforts and a three-month delay due to a lawsuit brought by a group of ADCOM civilians, HQ USAF proceeded to dismantle the command. Air defense resources transferred to TAC on 1 October 1979, with missile warning and space surveillance resources going to SAC on 1 December 1979. Formal disestablishment of ADCOM as an Air Force major command occurred on 31 March 1980. Meanwhile, an Aerospace Defense Center (ADC) had been activated from ADCOM remnants in Colorado Springs to train and equip people to support the space surveillance and missile warning missions. At that point, consolation for Under Secretary Mark, retired General Hill, and others who supported creation of a space command lay in the possibility that one might rise phoenix-like from ADC.[17]

They had reason to remain cautiously optimistic. When Secretary Stetson had approved the "reorganization" of ADCOM in late summer 1978, he had suggested that US Air Force Chief of Staff General Lew Allen, Jr., appoint a special, high-level group of general officers to advise how the service should organize itself to perform space operations.[18] In response, General Allen authorized an executive committee of general officers led by Lt Gen Andrew B. Anderson, Jr., the HQ USAF deputy chief of staff for plans and operations, to examine all aspects of space-mission management and propose organizational alternatives. The committee, in turn, created a working group that included several lower-ranking officers who later would occupy important positions in Air Force Space Command: Col Gaylord W. "Wes" Clark; Lt Col Thomas S. Moorman, Jr.; and Maj Robert S. Dickman. Their product, the *Space Mission Organization Planning Study* (SMOPS), issued as a top-secret report on 5 February 1979, set the parameters for discussions over the next three years.

The SMOPS identified five organizational options for the space mission. As General Hill pointed out, the first—to retain the current organizational structure—had been preempted by the decision to disestablish ADCOM. That left four alternatives: give the space mission to SAC; give it to AFSC; create a separate Space Operations Service under AFSC; or establish a new major command for space operations. General Hill prodded General Allen to support establishment of a space command using "as its cadre the personnel presently assigned to ADCOM for space management." On the eve of his retirement in December 1979, General Hill again addressed the Air Force chief of staff on this issue:

> "Unless we make an explicit organizational decision which assigns to a single organization the Air Force responsibilities in space operations once and for all, we will be faced with negative long-term impacts on resource management and planning. In my judgment, we can no longer afford the luxury of so many groups and diversified interests sharing responsibility for the space activities that have progressed beyond development and are (now) operational."[19]

A 1980 Air Force Scientific Advisory Board "Summer Study on Space," under the leadership of former Secretary of the Air

Force John L. McLucas, reinforced General Hill's opinion by concluding that, although the service had done well during the preceding fifteen years turning experimental systems into reliable, operational ones, it was organized inadequately for operational exploitation of space and placed insufficient emphasis on the inclusion of space systems as essential elements in an integrated force structure. That General Allen still remained aloof might have reflected his preference for compromise and his inclination to proceed cautiously until a strong service-wide consensus outweighed the more parochial interests of individual commands. His personal doubts about the need for change almost certainly were matched by his awareness that precipitous action might generate unwanted opposition from the Joint Chiefs of Staff, the other services, and DoD agencies.[20]

Nonetheless, high-level policy and doctrine statements ensured continuation of spirited discussions about how the Air Force ought to organize for space operations. Presidential Directive No. 37 on 11 May 1978 asserted the nation's right to free passage and unhampered operation of its property in space and, consequently, its right to defend that property against hostile threats. Publication of Air Force Manual 1-1, *Functions and Basic Doctrine of the United States Air Force,* on 14 February 1979 for the first time officially identified space operations as one of the service's basic missions. That recharged the ongoing debate about whether space was primarily an operating medium or a mission area, as divergent opinions at both the early 1981 Air University Airpower Symposium and the April 1981 USAF Academy Space Doctrine Symposium revealed. In the latter forum, AFSC Space Division Commander Lt Gen Richard C. Henry emphasized how the highly technical nature of spacecraft construction and orbital support made it very difficult to separate acquisition from operations, but several lower-ranking officers delivered papers advocating either evolutionary or immediate formation of a separate major command for space operations.[21]

By autumn 1981, several organizational changes related to space operations already had put the Air Force on a path that made creation of a space command more probable. In October 1979, a Defense Space Operations Committee had become the primary advisory body to the Secretary of Defense on issues related to national-security space. On the Air Staff, in the "F ring" down in the Pentagon basement, a space division (XOORS) spun off from the reconnaissance division with a congressional mandate to focus on Tactical Employment of National Capabilities. Secretary of the Air Force Hans Mark said in September 1980 that the Air Force, to strengthen its forces, must improve its ability to conduct operations in space and must develop proper organizational arrangements to deal with that new role, which compelled creation of a "Deputy Commander for Space Operations" position within the AFSC Space Division at Los Angeles. In September 1981, HQ USAF created a Directorate of Space Operations (XOS) under the Deputy Chief of Staff for Plans and Operations.[22]

In late summer 1980, a pair of relatively "unsung heroes" in Air Force space history—Lt Gen Jerome F. O'Malley and Maj Gen John T. Chain, Jr.—had become HQ USAF deputy chief of staff for plans and operations (XO) and director of operations, respectively. At his first staff meeting, General O'Malley asked the XO staff to prioritize what they believed were the most significant issues facing the service. Afterward, when General Chain mentioned to his staff that properly organizing for space operations came in second only to maintaining strategic-deterrent posture, Colonel Van Inwegen, then chief of Major General Chain's XOORS, remarked, "Well, we've got ten 'Billy Mitchells' of space here ready to work the problem." General Chain directed Colonel Van Inwegen's team—including Roger DeKok, Bill Savage, John Hungerford, Vito Pagano, and John Angel—to generate a "fester briefing" for General O'Malley that outlined an operational space organization and that explained why it should be a separate Air Force major command. When Colonel Van Inwegen asked why the general called it a "fester briefing," Chain replied, "I'm going to put it on General O'Malley's desk, and it's going to sit there and fester until he does something about it."

The best rationale Colonel Van Inwegen's team could provide for an organizational change was that "space operations, such as they were in the Air Force, were primarily almost totally research and development in nature, run by Space Division/SAMSO and the Air Force Systems Command or … the [National Reconnaissance Office] NRO." When they finally took the briefing to General O'Malley, "he came unglued," because he knew such reasoning would not impress General Allen, the chief of staff and a former AFSC commander. General O'Malley, who feared it would harm their cause significantly if General Allen reacted negatively to the briefing, said he would not allow it to go forward until the team came up with a better rationale.[23]

Two more high-level analyses related to Air Force space organization appeared in late 1980 and early 1981. First, using the SMOPS as a point of departure, the "SAF/ALS Space Organization Study" favored a new, operational command for space. Five months later, in May 1981, General O'Malley approved a "Space Policy and Requirements Study" that focused operationally on the service's space posture and the best means of providing required space capabilities.[24]

By summer 1981, a unique cast of characters occupied key senior-leader positions from which to influence creation of a space command. On the Air Staff, General O'Malley remained XO, with General Chain having become his assistant in July 1981, and Colonel Van Inwegen assigned as the first XOS in September. Lieutenant General James V. Hartinger, who had been NORAD commander in chief since January 1980, won a personal campaign to receive his fourth star on 1 October 1981. One of his West Point classmates from the late 1940s, Lt Gen Richard C. Henry continued to serve as commander of Space Division in Los Angeles while another, General Richard T. "Tom" Marsh, became AFSC commander in February 1981.

Meeting privately at Andrews AFB, Maryland, in August 1981, Generals Hartinger and Marsh agreed to raise the issue of an operational space command at the February 1982 Corona South meeting of Air Force senior leaders. During that meeting at Homestead AFB, Florida, discussions in all the closed-door executive sessions over three days focused on the skeletal proposal for a space command. General Marsh told his fellow "four-stars" the existing arrangement provided an insufficient interface between system designers and users. He proposed an evolutionary approach toward an operational space command, with the Space Division commander being "dual-hatted" in the near term to per-

Enlisted personnel unfurl Space Command flag during activation ceremonies at Peterson AFB, Colorado, 1 September 1982, while Air Force Under Secretary Edward C. Aldridge, Jr., Air Force Vice Chief of Staff Gen Jerome F. O'Malley, and Commander of Space Command Gen James V. Hartinger stand at attention.

sonally link the two communities. Finally, on the last day, during the last five minutes of the last session, General Allen directed Generals Hartinger and Marsh to prepare by mid-April a more detailed briefing on how to move toward an operational command for space.[25]

Pressure from above and outside the Air Staff undoubtedly made the Air Force chief of staff more receptive to what Generals Hartinger and Marsh were proposing. Testifying before the Senate Armed Services Committee in November 1981, Air Force Under Secretary Edward C. "Pete" Aldridge, Jr., had acknowledged the need for a more coordinated, integrated approach to military space operations and suggested establishment of "some form of a 'space command'" as the right answer. That same month, he told an audience at the American Astronautical Society national conference, "I believe the right answer may be to form a space command to operate our satellites and launch services."[26] On 8 December 1981 in the US House of Representatives, Colorado's Ken Kramer introduced a bill requiring the Air Force to report on the desirability of creating a space command and renaming the service itself the "United States Aerospace Force." Secretary of the Air Force Verne Orr and General Allen opposed the name change but acknowledged they were seriously considering a new command. Two months later, on 9 February 1982, Representative Kramer addressed the Military Reform Caucus, saying the United States should reorient its approach conceptually and organizationally to protect more directly its presence on the "high seas of space."[27]

Additional pressure for organizational change came at the end of January 1982 when the General Accounting Office (GAO) sent Congress a report criticizing the DoD for poor management of space systems and recommending designation of a single manager for military exploitation of space. Identifying the CSOC as the potential "nucleus for a future space force" or a "future space command," the GAO recommended that Congress withhold CSOC funding until the DoD presented an overall plan for military exploitation of space.[28]

Pursuant to General Allen's "Corona South" directive, Hartinger's and Marsh's staffs formed working groups to develop the Air Staff briefing. Although the groups met periodically to review each other's work, they did not exactly find common ground. Considering the fragmented management of Air Force space activities among 26 different organizations, the absence of a clearly defined operational advocate for space systems, and the lack of concrete plans for using space systems in wartime, Hartinger's staff pushed vigorously for immediate, revolutionary action to create a separate space command. Marsh's staff, on the other hand, favored a slower, evolutionary approach. When General O'Malley, who had been visiting the USAF Academy, dropped by the Chidlaw Building in Colorado Springs on 15 April 1982, Hartinger's staff showed him an extra briefing chart they had prepared to depict how a space command might be formed at once. Liking what he saw, O'Malley told Hartinger to bring the chart when he came to Washington to brief General Allen.[29]

That all-important briefing session occurred two days later on 17 April 1982, which happened to be General Hartinger's 57th birthday. After hearing System Command's formal presentation on the "Space Organizational Issue," General O'Malley objected to its vagueness about when an operational space command might be formed. As the discussion subsided, General Hartinger revealed his more specific transparency showing how the Air Force might create, without delay, a space command on par with SAC, TAC, and MAC. General O'Malley exclaimed, "That's it! That's what we need!" General Allen calmly concurred, "OK, Jimmy, you go back out to Colorado Springs, and let's get a space command started." The Air Staff Space Operations Steering Committee, chaired by General Chain, who had succeeded General O'Malley as the XO when the latter became Air Force vice chief of staff at the beginning of June 1982, subsequently worked to refine the organizational concept and plan the transition. On 21 June 1982, the service officially announced its decision to form Space Command effective 1 September 1982.[30]

With Air Force Vice Chief of Staff Gen Jerome F. O'Malley and Air Force Under Secretary Edward C. Aldridge, Jr., observing, Gen James V. Hartinger signs Special Order GD-1 on 1 September 1982, to become Space Command's first commander.

Space Shuttle Enterprise atop NASA Boeing 747 Shuttle Carrier Aircraft takes off from Colorado Springs, 18 May 1983, enroute from Dryden Flight Research Center, Edwards, California to Le Bourget Airport, Paris, France for Paris Air Show. Having landed at Peterson AFB two days earlier and coinciding with ground breaking for the CSOC, this was the Shuttle's first and only visit to Colorado Springs.

Time would prove, however, that establishment and activation of Space Command did not mean immediate consolidation of responsibilities for space-related operations. It would take until May 1983 for SAC to transfer control of all ground-based early warning and space surveillance sensors, plus DSP and DMSP resources. Management of GPS resources came in 1984, followed by the Air Force Satellite Control Network common-user element in 1987, space launch in 1990, Air Force astronauts in 1991, the Air Force Satellite Communications System in 1992, and intercontinental ballistic missiles in 1993. Not until 2001, with the transfer of Space and Missile Systems Center from Air Force Materiel Command, would Air Force Space Command (AFSPC) gain something akin to cradle-to-grave control over space systems.

Over those same two decades, many events would affect significantly how AFSPC met its growing responsibilities. A unified, operational organization with Air Force, Army, and Navy components would come and go; activated at Colorado Springs on 23 September 1985, United States Space Command would inactivate in 2002 and transfer its responsibilities to United States Strategic Command. After twenty-four successful flights, the Space Shuttle would suffer a catastrophic launch failure on 28 January 1986, which would change fundamentally how the Air Force planned to launch future satellites and, ultimately, would influence how the service defined "Military Man in Space" requirements. Operation Desert Storm in 1991 would demonstrate for the first time the full range of space-based capabilities for tactical purposes, even though nearly all of those capabilities had been designed originally for strategic purposes. The Cold War would end with collapse of the Soviet Union later that year, but the attacks of 11 September 2001 would signal a Global War on Terrorism. In 2007, on the twenty-fifth anniversary of the command's establishment, the men and women of AFSPC would have reason to wonder what challenges and changes might occur in the next quarter-century.

Notes:

[1] Gen James V. Hartinger, commander, Space Command, "Space Military Challenges and Opportunities" (address, Air Force Association Symposium, Washington, DC), 16 September 1982; David N. Spires, ed., *Orbital Futures: Selected Documents in Air Force Space History* (Peterson AFB, Colorado: AFSPC Office of History, 2004), 679-687. The general said, "First, why a space command and why now? It was just a matter of time, because, as General Dick Henry said, space is a place—like land, and sea and air—a theater of operations. And it was just a matter of time until we started treating space like a theater of operations."

[2] Quoted in Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1961-1984* (Maxwell AFB, Alabama: Air University Press, 1989), 686.

[3] General Russell E. Dougherty, CINCSAC, to General David C. Jones, HQ USAF/CC, 14 April 1977, in Spires, "*Orbital Futures*," 1:558-560; Brig Gen (USAF, retired) Earl S. Van Inwegen III, "The Air Force Develops an Operational Organization for Space," in R. Cargill Hall and Jacob Neufeld, eds., *The US Air Force in Space: 1945 to the Twenty-first Century* (Washington, DC: USAF History and Museums Program, 1998), 136; Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in Roger D. Launius, ed., *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue* (San Diego, California: Univelt, 1995), 176.

[4] Thomas O. Paine, NASA administrator, and Robert C. Seamans, Jr., secretary of the Air Force, "Agreement … Concerning the Space Transportation System," 17 February 1970, in Spires, "*Orbital Futures*" (2004), 2:860-870; Robert Kipp, AFSPC/HO, "Background Paper on Formation of Space Command," 8 March 1988.

[5] Sturdevant, "The United States" (1995), 173-174.

[6] General Lucius D. Clay, Jr., ADC/CC, to HQ USAF/CC, "Operational Responsibility for the Space Transportation System (STS)," 23 April 1974, Spires, *Orbital Futures* (2004), 2:871-872.

[7] Ibid., 2:872-882.

[8] General Daniel James, Jr., ADCOM/CC, to General David C. Jones, HQ USAF/CC, memorandum, 4 April 1977; Brig Gen William E. Lindeman, ADCOM/XP, to ADCOM/CC et al., "Space Mission Control Facilities," 3 November 1978; Capt T. Tony Tunyavongs, "A Political History of the Establishment of Space Command," *Quest: The History of Spaceflight Quarterly* 9, no. 1 (2001), 34.

[9] "Consolidated Space Operations Center Lacks Adequate DOD Planning," GAO Report MASAD-82-14, 29 January 1982, http://archive.gao.gov/d41t14/117451.pdf. In 1982, with reference to the SOPC portion of the CSOC, Gen James Hartinger, Space Command commander, "supported avidly" by former Secretary of the Air Force Hans Mark, proposed funding a dedicated Military Space Transportation System (MSTS) in the FY84 Program Objective Memorandum (POM), "but, regrettably, funds were not approved and made available." See Memo, NRO/HO to AFSPC/HO, "Transfer Custody of MSTS Illustration," 26 March 1999.

[10] Van Inwegen, "The Air Force Develops" (1998), 136; Brig Gen (USAFA, retired) Earl S. Van Inwegen, interview with the author, 1 November 1995.

[11] Van Inwegen, "The Air Force Develops," (1998), 136-137; Van Inwegen, interview (1995); USAF Special Study Group, "Proposal For: A Reorganization of USAF Air Defense and Surveillance/Warning Resources," January 1978. At almost the same time as General Creech's study, the US Congress studied shifting ADCOM functions to TAC and SAC. Testifying before the House Committee on Appropriations in early February 1977, HQ USAF Director of Programs Major General Abbott C. Greenleaf had cautioned against such action on the grounds it "would cause fragmentation of a specialized area of responsibility, would not provide any manpower/force savings and possibly cause a major reorganization of the NORAD defense structure." By early summer 1977, however, the Appropriations Committee "directed its Surveys and Investigations Staff to conduct a review of need to support a separate ADC[OM] headquarters and command structure and what savings and other program improvements might result from transferring the responsibilities and assets of ADC[OM] to SAC and TAC." See "Congressional Testimony on Missions of TAC and ADCOM: Questions and Answers for the Record, House of Representatives Subcommittee of the Committee on Appropriations," 8 February 1977; House of Representatives, 95th Congress 1st Session, "Department of Defense Appropriation Bill, 1978," Report no. 95-451, 71; and "House Unit Studies Shifting

ADC[OM] Functions to TAC, SAC," *Aerospace Daily,* 30 June 1977, 341.

[12] Van Inwegen, "The Air Force Develops" (1998), quote, 137.

[13] Van Inwegen, interview (1995).

[14] Van Inwegen, "The Air Force Develops" (1998), 137-138; Van Inwegen, interview (1995).

[15] Van Inwegen, "The Air Force Develops" (1998), 138; Van Inwegen, interview (1995); Lt Col E. S. Van Inwegen, ADCOM/XPDQ, "Need for a USAF Space Operations Command," 8 June 1978.

[16] Lt Col Charles H. MacGregor and Maj Lee H. Livingston, "Air Force Objectives in Space," *Air University Review* 29, no. 5 (July-August 1978), 60-62, http://www.airpower.maxwell.af.mil/airchronicles/aureview/1978/jul-aug/macgregor.html; Hans Mark, under secretary of the Air Force, to John C. Stetson, SecAF, "Reorganization of NORAD/ADCOM," 7 August 1978, in Spires, *Orbital Futures* (2004), 1:561-563; Sturdevant, "The United States Air Force Organizes for Space" (1995), 176.

[17] Robert Kipp, AFSPC/HO, "The Reorganization of 1979 and the Space Organization Issue," 8 March 1988; Futrell, "Ideas, Concepts, Doctrine"(1989), 2:689; David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership*, rev. ed. (Maxwell AFB, Alabama: Air University Press, 1998), 193-196. Since July 1975, ADCOM had a dual status as a USAF major command and a JCS specified command. Despite disestablishment as a major command in March 1980, the specified ADCOM remained as a component of NORAD until disestablished in December 1986. See Robert M. Kipp, *A Handbook of Aerospace Defense Organization, 1946-1986* (Peterson AFB, Colorado: AFSPC History Office, n.d.), 6-10.

[18] John C. Stetson, SecAF, to General Lew Allen, HQ USAF/CC, "ADCOM Reorganization," 11 September 1978, in Spires, *Orbital Futures* (2004), 1:563-564.

[19] General James Hill, ADCOM/CC, to General Lew Allen, HQ USAF/CC, [December 1979], quoted by Kenneth B. Kramer to Melvin Price, 2 February 1982, in Tunyavongs, "A Political History" (2001), 37.

[20] General James E. Hill, CINCAD, to General Lew Allen, HQ USAF/CC, 5 February 1979, and HQ UAF/XO, *Space Mission Organization Planning Study,* 5 February 1979, in Spires *Orbital Futures*, (2004), 1:565-602; Sturdevant, "The United States Air Force Organizes for Space," (1995), 177; Spires, *Beyond Horzions* (1998), 196-199.

[21] Sturdevant, "The United States Air Force Organizes for Space," 1995, 177-178; R. Cargill Hall, "National Space Policy and Its Interaction with the US Military Space Program," Military Space and National Policy: Record and Interpretation (George C. Marshall Institute, 2006), 11-13, http://www.marshall.org/pdf/materials/419.pdf.

[22] Robert Kipp, AFSPC/HO, "Formation of Space Command," 8 March 1988; Van Inwegen, "The Air Force Develops" (1998), 138-140; Van Inwegen, interview with author (1995).

[23] Van Inwegen, interview with author (1995). An incident in September 1981 lent credence to Gen O'Malley's concern about General Allen's possible reaction. *Aviation Week* reporter Craig Covault had inquired about the reasons for creation of XOS and had written a one-page article stating "the directorate of space was formed to dispel Air Force attitudes that tended to view space as [research and development] R&D and not operations." When General Allen read this, he reportedly said, "If that's what the space cadets in the basement think, they'll never get out of the basement of this building!" See Van Inwegen, interview with author (1998), 140-141.

[24] Spires, *Orbital Futures* (2004), 1:610-661.

[25] Gen (USAF, retired) James V. Hartinger, interview with author, 20 August 1992. Also in February 1982, Brig Gen Neil Beer, NORAD assistant deputy chief of staff for plans, briefed the rationale for a space command at an Air Force Planners Conference. See Van Inwegen, "The Air Force Develops" (1998), 141.

[26] Sturdevant, "The Air Force Organizes for Space" (1995), 178; Van Inwegen, "The Air Force Develops" (1998), 141.

[27] Verne Orr to Ken Kramer, 11 December 1981, and Ken Kramer to Melvin Price, 2 February 1982 in Spires, *Orbital Futures* (2004), 1:662-670; Sturdevant, "The Air Force Organizes for Space" (1995), 178; Tunyavongs, "A Political History" (2001), 37-38. Also, around the same time as the February 1982 "Corona South" meeting, the under secretary of the Air Force (SAFUS) sent a letter to the USAF Vice Chief of Staff (HQ USAF/CV) requesting a review of organizational options for space, with a recommendation back to SAFUS before summer 1982. See Spires, *Orbital Futures* (2004), 1:672-673.

[28] GAO Report (MASAD-82-14), 29 January 1982; Thomas Karas, The New High Ground: Strategies and Weapons for Space-Age War (New York: Simon & Schuster, 1983), 19; Futrell, *Ideas, Concepts, Doctrine* (1989), 2:695.

[29] Hartinger, interview with author (1992); Van Inwegen, interview with author (1995); Van Inwegen, "The Air Force Develops" (1998), 142; Maj Gen Thomas S. Moorman, Jr., special assistant for SDI to AFSC/CV, interview transcript, by Robert Kipp and Thomas Fuller, AFSPC/HO, 27 July 1988, 15-18.

[30] Spires, *Beyond Horizons* (1998), 202-207; Sturdevant "The United States Air Force Organizes" (1995), 180; Moorman, interview transcript (1998), 18-20; Hartinger, interview with author (1992); James V. Hartinger, General Jim Hartinger: From One Stripe to Four Stars (Colorado Springs, Colorado: Phantom Press, 1997), 245-248. Although skeptical about the immediate need for a space command, General Allen later explained that he approved its creation in order that he might "have as much influence as I could in having the command structure not be overblown but get it underway" before he retired on 1 July 1982. See Interview transcript, General (USAF, retired) Lew Allen, Jr., by Dr. James C. Hasdorff, 8-10 January 1986, 164. Perhaps because he felt his organization had the most to lose if the USAF established a space command, CINCSAC Gen Bennie L. Davis voiced the most opposition to that idea. He and Lt Gen George D. Miller, his vice chief of staff, preferred a space service. See Interview transcript, Gen (USAF, retired) James V. Hartinger, by Capt Barry J. Anderson, 5-6 September 1985, 167-168; Spires, *Orbital Futures,* (2004), 1:673-676.

Dr. Rick W. Sturdevant (BA, History, University of Northern Iowa; MA, History, University of Northern Iowa; PhD, University of California, Santa Barbara) is deputy command historian, Headquarters Air Force Space Command (HQ AFSPC), Peterson AFB, Colorado. He joined the Air Force History and Museums Program in April 1984 as chief historian, Airlift Information Systems Division, Scott AFB, Illinois, and moved one year later to the Chidlaw Building near downtown Colorado Springs as chief historian, Space Communications Division (SPCD). When SPCD was inactivated in 1991, he moved to the HQ AFSPC history office and became deputy command historian in 1999.

An acknowledged expert in the field of military space history, Dr. Sturdevant appears frequently as a guest lecturer on space history topics and is author or co-author of chapters or essays in *Beyond the Ionosphere: Fifty Years of Satellite Communication* (1997); *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue* (1995); *Golden Legacy, Boundless Future: Essays on the United States Air Force and the Rise of Aerospace Power* (2000); *Air Warfare: An International Encyclopedia* (2002); *To Reach the High Frontier: A History of US Launch Vehicles* (2002); *The Limitless Sky: Air Force Science and Technology Contributions to the Nation* (2004); and *Encyclopedia of 20th-Century Technology* (2005). His articles or book reviews have appeared in such journals as *Space Times*, *Journal of the British Interplanetary Society*, *Air & Space/Smithsonian*, *Quest: The History of Spaceflight Quarterly*, *Air Power History*, *High Frontier: The Journal for Space & Missile Professionals*, and *Journal of the West*. He sits on the editorial board of *Quest* and on the staff of *High Frontier*.

Dr. Sturdevant is an active member of the American Institute of Aeronautics and Astronautics (AIAA), American Astronautical Society (AAS), British Interplanetary Society (BIS), and Society for the History of Technology (SHOT). His professional honors include the Air Force Exemplary Civilian Service Award (1995-1999) and the AAS President's Recognition Award (2005).

Northrop Grumman's Partnership with Air Force Space Command: Building on a History of Successes

Mr. Wes Bush
President and Chief Operating Officer
Northrop Grumman Corporation

A Productive Partnership

Since its activation in 1982, Air Force Space Command (AFSPC) has extended its leadership role dramatically, as the operator of critical Cold War deterrence capabilities, the major acquirer of America's space assets and the prime integrator of space capabilities into domains and missions of the other services. AFSPC has given America 25 years of remarkable accomplishments in military space.

These include many successful missions that Northrop Grumman Corporation has been privileged to support; the longstanding partnership between AFSPC and our company has been tremendously productive.

Shortly after its activation, AFSPC took over responsibility for the missile warning mission around the world, and since 1993 has been responsible for the land-based intercontinental ballistic missile (ICBM) force as well.

Northrop Grumman is a key supporter of both these strategic missions. Missile warning satellites of the Defense Support Program (DSP), developed by Thompson Ramo Wooldridge Inc. (TRW) in the 1970s, have been a critical mainstay of deterrence both during and since the Cold War. While detecting ballistic missiles fired around the world throughout that period, these satellites have also set records for reliability, averaging four times their design life requirements.

In addition, building on the leading role in the ICBM program from its inception, Northrop Grumman heads a team ensuring the readiness, reliability and surety of 500 Minuteman III missiles on alert at three AFSPC wings. Key to this program's success are the systems engineering methods invented by the Air Force-TRW partnership for ICBM programs in the 1950s (now the industry standard). These methods are critical for dealing with incredibly complex, defense-unique systems that each include more than 5,000 configuration items.

With Desert Shield/Desert Storm, AFSPC achieved major advances in force enhancement. Subsequently, in Operation Allied Force and later conflicts, space was further integrated into joint, allied, and coalition operations.

Northrop Grumman supported these force-enhancement missions with DSP's capability for theater missile warning; payloads for the Defense Meteorological Satellite Program; and payloads for the highly secure five-satellite Milstar communications constellation.

Northrop Grumman has also played a key role in AFSPC's Space Support mission area, including range support activities at Patrick AFB, Florida and Vandenberg AFB, California.

Mission Requirements Shaping Future Acquisitions

AFSPC's 25th anniversary marks a fitting moment not only to recount our partnership's joint successes, but also to focus attention on our many current and future opportunities for achieving great things together.

We will encounter continuing exciting prospects for developing new capabilities needed to deal with more complicated security environments. I will discuss some of the missions and

Figure 1. Over more than 36 years of service, Defense Support Program satellites have averaged four times their design life requirement.

Figure 2. The Minuteman III ICBM is being aggressively modernized by AFSPC and a Northrop Grumman-led team.

capabilities we are likely to be working on together, and also some new approaches we can emphasize in our collaboration, which will help us be even more successful.

In the strategic arena, America faces a diversity of challenges.

Twelve nations now have nuclear weapons (proliferation of weapons of mass destruction [WMD] is also a major worry), and 28 have ballistic missiles that can be used as delivery systems. Concerns of US government leaders have been aroused by North Korean Taepo Dong II missile capabilities, Iran's nuclear development program and policy stance, and the longer term intentions of China as a nuclear and space power.

At present, the president has few alternatives for responding to threats from rogue nations. Thus, to remedy this situation the nation's strategic deterrence system is being extended beyond the traditional triad to include time-critical conventional strike and missile defense.

Because Minuteman III provides the bulk of our day-to-day deterrent capability, it continues to be crucial to our national security. Consequently, the system is being aggressively modernized by AFSPC and the Northrop Grumman-led team to extend its readiness well beyond 2020. These efforts encompass missile stages—for instance, modifying the re-entry vehicle, upgrading aging rocket motors and propellant, and replacing guidance system electronics—as well as the launch control centers.

The additional elements of the nation's strategic deterrence system now being planned or developed will provide many opportunities for government-industry collaboration.

We may well see development of a conventionally armed ballistic missile under the Prompt Global Strike initiative.

Further, strategic defensive capabilities are being expanded by the Missile Defense Agency's (MDA) multi-layered missile defense system. Space capabilities, including missile warning sensor satellites, are fundamental enablers for these missile defense systems.

Sensor satellites now under development include the Space-Based Infrared System (SBIRS) and the Space Tracking and Surveillance System (STSS) constellations; the former to monitor worldwide missile launches and the latter to track enemy missiles during their boost, midcourse and terminal phases of flight. Northrop Grumman is payload provider for SBIRS and prime contractor for demonstration satellites for STSS - MDA's first space tracking and surveillance sensors, which are scheduled to launch in 2008.

Figure 3. The Space Tracking and Surveillance System will track enemy missiles during all phases of flight.

In developing these and other future generation space systems, just as in designing additional strategic deterrence options, the national security establishment is preparing for missions geared to our era's uncertain and diverse threat environment. The nation needs space systems that help our military and other security forces engage or otherwise respond not only to conventional enemies, but also rogue states, terrorists, adversaries possessing WMD, emerging powers, and natural disasters.

In addition, we need space systems for the important mission of protecting the expanding fleet of satellites that have become indispensable both for national security and economic competitiveness. Some of the same adversaries just mentioned are aware of our growing strategic vulnerability and pose serious threats to our space assets as they themselves gain greater access to space.

AFSPC Commander General Kevin P. Chilton has stressed that the need for space situational awareness, including an understanding of the cause of any interruption in satellite operations, "increases exponentially as our joint forces become more dependent on space."[1]

The Bush administration's national space policy (August 2006), while referring to all four of the key space mission areas (space support, force application, force enhancement, and space control), gives special emphasis to the latter in underlining the nation's intention to preserve its rights, capabilities, and freedom of action in space.[2]

Space Capabilities for an Era of Uncertain Threats

Given these various mission areas to support, what kind of space systems will AFSPC and industry be developing together?

Current space systems differ from weapon systems, of course, in that they support military engagement indirectly, through the information services they provide. Thus, adapting them to a more uncertain and diverse threat environment means increasing the diversity, quality, quantity, and speed of information they can deliver. For instance, improvements must be achieved in the number and positioning of satellites, the spectral range and sensitivity of satellite sensors, the capabilities of processing algorithms, and the bandwidth of communications satellites. And, as the Department of Defense Plan for Operationally Responsive Space states, there is a requirement for "assured space power focused on timely satisfaction of Joint Force commanders' needs."[3]

As is clear from recapitalization efforts we are already participating in, the AFSPC-industry partnership will be preparing for threat and mission diversity by creating:

- Missile warning systems that have improved capabilities for monitoring all types of ballistic missiles throughout their flight trajectories, and for detecting space or high-atmospheric tests conducted even by low-performance, entry-level weapons in difficult monitoring environments;
- Intelligence, surveillance, and reconnaissance systems better able to penetrate denied areas to find, fix, track, target, and assess targets of varying sizes (from large weapons

systems to individuals), speeds, and in different environments—providing day-night, all-weather, persistent surveillance capability throughout the world;

- Terrestrial and space environment monitoring systems that enable more precise advanced warning of severe conditions (such as hurricanes and geomagnetic storms), and breakthrough contributions to mission planning and operations across the military services;
- Position, navigation, and timing systems that deliver greater accuracy, security, and reduced vulnerability to jamming;
- Communications systems that transfer much more information much faster—that enable communications even for forces on the move and that fully realize the Pentagon's vision of joint operations based on integrated netcentric architectures; and
- Space surveillance systems that substantially increase our awareness of threatening space objects—and, perhaps, missile warning systems like STSS that may be adaptable for a space surveillance role as well.

Much of our future work together will be focused on systems like these, systems so advanced that any one of them may well drive major concept of operations changes, just as global positioning system (GPS) did.

As the industry-government collaboration on GPS taught us, to succeed with any revolutionary system we will have to surmount a variety of management challenges. For example, we will have to secure political commitment and stable financial support for the system; build early consensus about system requirements among the multiple groups that are jointly developing it; and increase operational familiarity with the system among users who show an institutional reluctance to accept its changes.[4]

Giving Priority to Innovation

Not surprisingly, however, some of the biggest challenges in developing such pacesetter capabilities involve engineering and program management issues.

We must ask, how can our partnership be most successful at solving technical problems of unprecedented difficulty, while meeting our targets for delivery on time and on budget? Certainly we must rely on and improve traditional approaches like systems engineering and process management that have enabled us to achieve earlier exceptional records of reliability.

That will help us repair the serious problems we have recently had in our recapitalization efforts and restore the credibility of the space community as trusted stewards of taxpayers' investments. In its emphasis on revitalizing these traditional disciplines, the "Back-to-Basics" approach being implemented by AFSPC can have a very positive impact.

It does not seem, however, that going back to *technology* basics is the right answer for problems in the space programs. I am concerned to see the debate about development strategies fostering the view that proper risk management restricts us to using only mature technologies.

Quite frankly, I believe the reverse is true, that the successes we are after will fundamentally require the incorporation of new technologies. As just noted, AFSPC's agenda for maintaining America's military space advantage centers on developing leap-ahead systems—and this objective, I believe, calls for developing new approaches to our work together that will enable us to innovate more dramatically and get the high-performance solutions we need much faster.

Our ability to manage risk as we develop and integrate new technologies is key—but we need to be careful that "risk management" is not translated into a view that all risk must be avoided. Such a view would surely over time destroy the technological advantage we enjoy today.

With the right form of tightly interwoven partnership, and a willingness to assume reasonable technology risks, it is possible to achieve amazing advances, cost control and schedule compression that together represent tremendous value.

We also must take a more global view of innovation. Most defense missions today take on an international alliance form of implementation. The same should be true of defense acquisition strategies. We need a government-industry partnership model that values and enables cross-border interactions aimed at gaining access to the best technology solutions for our security.

One of the biggest barriers to forming such relationships has surely been the US State Department's administration of export policy as part of the International Traffic in Arms Regulations (ITAR). In the commercial marketplace, where this policy regulates spacecraft as munitions, many international customers simply give up on US satellite deals to avoid the risk involved in dealing with ITAR red tape. Thus, in considering possibilities for international military cooperation it's hard to see how we can even get out of the starting blocks without some reform of this restrictive policy.

We do need to achieve the all-important goal of keeping military technology out of the hands of adversaries. But we must do this with rules that also enable us to collaborate with our allies in joint development relationships, joint economic ventures, and bilateral and multilateral programs. Our government-industry partnership must work together to influence new policy directions that will facilitate such endeavors.

The cost of our failure to form international partnerships in defense emerges clearly when we consider the breathtaking technology feats chalked up by international partnerships in civil space.

The James Webb Space Telescope, with seven times the light-gathering ability of the Hubble, will look back much farther in time, providing a window into a period when the universe was only a few hundred million years old. This Northrop Grumman-led project is relying on European partners for two of the four instruments, as well as the launch.

The Cassini-Huygens mission, launched in 1997, is now orbiting Saturn on a four-year exploration of the planet and its rings, moons, and complex magnetic environment. This mission is a joint effort of NASA, European Space Agency, and Italian Space Agency. The effort is managed for NASA by Jet Propulsion Laboratory. Partners include academic and industrial participation from 17 countries.

Our government-industry partnership must find a way to harness this remarkable creativity that is being generated in other nations.

While innovation depends on building creative teams, it also depends on something more general and strategic: ensuring we will have the human capital resources we must have to carry out the projects I have been discussing.

Government and industry managers both find it increasingly difficult to staff our organizations with the skilled people we need. General Chilton makes addressing such staffing issues a major priority.[5]

One factor is the nation's inability to graduate enough qualified engineers. Another is the large number of aerospace employees approaching retirement in the next few years.

I think this issue is well understood, and we are all working hard to build additional strength in a broad range of critical competencies.

We are working to improve K-12 education in math and science, and also to give teachers experiences that will allow them to bring the excitement of science and engineering into the classroom. We are working with university engineering and business schools to provide counsel about curriculum and opportunities for cooperative working assignments. There are also useful policy initiatives being pursued—for instance, tax incentives for investment in engineering education.

Steps like these should succeed in generating more scientists and engineers—but will they solve our defense industry staffing problems? That depends, of course, on whether or not these talented people choose careers with our organizations.

There is a simple rule that applies here: technology attracts talent. The rate of change and innovation in any domain can be correlated with the intellectual capacity being applied—and the more talent that arrives, the faster the productive change cycle that results. Domains where innovation declines see talent departing—and not entering.

Conclusion—Continuing Our Successes

Innovation has long been a key strength of the AFSPC-industry partnership. But given the challenges ahead, it is a strength we must keep building. We must increase the innovation level of our partnership culture by sustaining and expanding our talented workforces, by making fuller use of the skills of space experts in international defense establishments, and by accepting the challenge of managing prudent risks for the payoff of greater capability and superiority.

Heightened innovation will be vital to helping us realize General Chilton's priorities and vision of delivering expanded space effects to the joint fight, providing safe and secure strategic deterrence, and making AFSPC the acknowledged leader in 21st century of space power.[6]

Equally important to helping us realize these priorities and vision will be our special AFSPC-Northrop Grumman relationship, extending throughout the life of the command and based on: shared excitement about the challenging, stimulating programs we work on together; shared allegiance in supporting America's defense of freedom and our warfighters' heroic service and sacrifice; and shared trust in each other based on long experience of our partners' expertise and integrity.

We are proud of our productive history together, and are committed to making sure every future anniversary of the command is one more occasion for celebrating our partnership's trajectory of success.

Notes:

[1] General Kevin P. Chilton, commander, Air Force Space Command, "Statement Before The House Armed Services Committee, Strategic Forces Subcommittee, United States House of Representatives," released 19 April 2007, 7, http://dailyreport.afa.org/NR/rdonlyres/6DD17294-429F-40A4-97AF-C8BD8DC172D9/0/041907Chilton.pdf.

[2] *US National Space Policy*, fact sheet, White House, US Office of Science and Technology Policy, released October 2006, secs. 2, 5, http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf.

[3] *Plan for Operationally Responsive Space*, Department of Defense, 20 March 2007, 2, http://www.responsivespace.com/Conferences/RS5/4=17=07%20ORS%20Plan.pdf.

[4] For discussion of these issues, see Dana J. Johnson, Senior Analyst, Northrop Grumman Analysis Center, "Overcoming Challenges to Transformational Space Programs: The Global Positioning System (GPS)," October 2006, http://www.analysiscenter.northropgrumman.com .

[5] General Chilton, "Statement," 25-29.

[6] General Chilton, "Statement," 3, 4.

Mr. Wes Bush (BS and MS, Electrical Engineering, MIT) is the president (appointed in May 2006) and chief operating officer (appointed in March 2007) for Northrop Grumman Corporation. He also serves on the company's corporate policy council. He was appointed corporate vice president and chief financial officer for the company in 2005. In 2003, he was appointed Space Technology sector president and held complete general management responsibilities for that business. Prior to the acquisition of TRW by Northrop Grumman, Bush had served since 2001 as president and CEO for TRW's UK-based global Aeronautical Systems.

Bush joined TRW in 1987 as a systems engineer and has held a series of increasingly responsible roles. In 1996 he was named program manager of a defense satellite program for the defense systems division, responsible for management of the satellite and ground segment developments, launch services, and operations and maintenance. He became vice president of TRW Space and Electronics' planning and business development in 1998, where his duties included managing the organization's planning, resource management, and strategic development initiatives.

Beginning in 1999, Bush was vice president and general manager of the telecommunication programs division. In this position he was responsible for managing the development and production of telecommunication systems and products with an emphasis on advanced satellite and terrestrial wireless communications.

From 2000 to 2001, he served as vice president and general manager of TRW Ventures, an organization focused on leveraging TRW's advanced technologies to create new business opportunities in commercial markets. Prior to joining TRW, Bush held engineering positions with both the Aerospace Corporation and Comsat Labs.

Bush is a graduate of UCLA's Executive Management Program.

Sharpening the Spear: 25 Years of Serving the Warfighter

Ms. Joanne M. Maguire
Executive Vice President
Lockheed Martin Space Systems Company

As we join in celebrating the 25th anniversary of the Air Force Space Command (AFSPC) we look with pride upon our partnership with the dedicated professionals who have normalized space operations within the culture and operations of the military, and put the focus where it must be—on the warfighter—on the ground, in the air and at sea. Recognizing the situations they face, and assuring America's sons and daughters in harm's way have the requisite tools to achieve success is our shared mission.

At the point of the spear, a special operations team is preparing for insertion into a high desert in the Middle East—on a battlefield of the near-future—to pinpoint and destroy mobile missile launchers commandeered by a terrorist cell. The missiles pose a threat to in-theater troop emplacements as well as population centers in friendly countries in the region.

Twenty-five years ago, the AFSPC vision was in many ways revolutionary. Today it is just good plain common sense. Prior to 1982, space programs were managed by the technical, developmental, and acquisition arms of Air Force. Upon creation of AFSPC, there was a dedicated effort—which continues to this day—to provide an organization to recruit, train, and educate a "space smart" military cadre. While focusing on the Air Force, all services send personnel to "learn and operate" space systems at Schriever AFB, Colorado, created specifically as a center in which young officers and Airmen become proficient in their trade.

Today, as a result of such visionary leadership, space operations experts permeate the Department of Defense, shaping its culture, doctrine and planning. AFSPC has succeeded in training, developing, and maturing leaders well-versed in integrating space capabilities into warfighter mission planning and the conduct of combat operations. As a side benefit, our industry has accessed this growing talent pool—hiring people to help stay in "strategic step" with the military as system requirements evolve.

High above, two Defense Meteorological Satellite Program spacecraft—half a world apart—orbit Earth from pole to pole. Passing over the insertion area they image visible and infrared cloud cover and measure precipitation, surface temperature, and soil moisture. Crucial information is immediately downlinked to the special operations command center and briefed to the team, describing conditions on the battlefield they are about to occupy.

Under AFSPC, space operators were charged with launch and satellite operations, and assigned responsibility for assessing mission deficiencies and defining system capability to optimize space effects on the battlefield. More recently, AFSPC has been given direct control of the Space and Missile Systems Center, Los Angeles AFB, California—a unique organizational alignment in the Air Force—giving the operator direct authority over the acquiring agency.

This major realignment the Air Force yielded needed change

Figure 1. Defense Meteorological Satellite (DMSP) spacecraft are used for strategic and tactical weather prediction to aid the US military in planning operations at sea, on land, and in the air. Equipped with a sophisticated sensor suite the satellites collect specialized global meteorological, oceanographic, and solar-geophysical information in all-weather conditions. The DMSP constellation comprises two spacecraft in near-polar orbits, command, control, and communications, user terminals, and weather centers.

Figure 2. The US Navy's Mobile User Objective System (MUOS) is a next-generation narrowband tactical satellite communications system designed to significantly improve ground communications for US forces on the move. MUOS satellites will provide the warfighter with the latest mobile technology such as simultaneous voice, video, and data, as well as improved service to legacy users of the Navy's Ultra High Frequency Follow-On (UFO) system.

and important benefits. Military users became directly involved with setting requirements for new systems. The imperative to be responsive to forces in the field at the unit level has driven integration of needed capabilities into combat operations. The emphasis has shifted to the warfighter, rather than the system.

As the combat team flies to their insertion point they access images of the battlespace from a Multiple User Objective System terminal aboard their chopper. A pair of unmanned aerial vehicles, already forward deployed, are silently circling above the target area providing real time imagery. Upon landing, the special operations team sets out under cover of darkness toward the target area.

Within the aerospace industry, this demanded that we become conversant in military missions and translate technical performance specifications of our systems into military utility metrics. But looking at things in this new way also enabled us to imagine a larger "system of systems" that would bring together the capabilities of communications, navigation, and surveillance, weather monitoring, and missile defense into an interoperable architecture that provides warfighters with complete situational awareness and information dominance. We now design and build advanced space-based military satellites, airborne assets and ground systems that individually perform specific functions, but work together as interlocking parts of a larger whole, providing greater reliability, redundancy, and the ability to improve the architecture as new capabilities become available.

The new paradigm requires that we thoroughly understand our customer's needs, and communicate both the challenges and opportunities we as contractors face in the implementation of a new vision. This has placed a premium on face-to-face interaction with our AFSPC customer, and so we have co-located people in Colorado Springs, at Vandenberg AFB, California and in Omaha at United States Strategic Command (STRATCOM). The strength of the partnership that has developed is based upon trust and a willingness to learn from one another about how best to serve the warfighter.

Figure 3. The Global Positioning System (GPS) IIRM satellites allow users equipped with a GPS receiver to determine velocity and worldwide position—latitude, longitude, and altitude—within a few meters. Both position data and velocity are given at a precise reference time. The GPS constellation works in concert with ground receivers to give precise location information to military and civilian users anywhere in the world. GPS provides such service as situational awareness and precision weapons guidance for the military. It is also an information resource supporting a wide range of civil, scientific and commercial functions—from air traffic control to the Internet—with precision location and timing information.

Figure 4. Space Based Infrared System (SBIRS) is the nation's next-generation missile warning system and will also provide greatly expanded capabilities for intelligence, surveillance and reconnaissance (ISR) missions. When fully operational, SBIRS will comprise two payloads in highly elliptical orbit (HEO), four satellites in geosynchronous orbit (GEO), as well as fixed and mobile ground-based assets to receive and process the infrared data.

The sharp focus by AFSPC on the warfighter has given the US an asymmetrical military strength in space that has provided the single greatest advantage for US forces over our adversaries. Today, with a fully mobilized space force, the US has no true peer competitor in terms of military might. Combatant commanders rely on space systems to fully realize their powerful potential.

As the team approaches the terrorists' position, they see from a distance that two of the three missile launchers appear to be in an operational configuration, and immediately alert the command authority. Terminal High Altitude Area Defense (THAAD) batteries—already in place for the protection of troops and civilians—are alerted and their radars begin scanning the skies. Global positioning system (GPS) coordinates of the missile emplacements are determined, and an air strike is requested.

The fielding of the GPS is a prime example of that unparalleled advantage, but also a brilliant illustration of the foresight shown by Air Force leadership in understanding and appreciating the potential of GPS. Initially, many viewed the system as expensive and unnecessary. But over time, GPS has pervaded planning and operations and maximized US power.

In World War II, thousand-plane raids were sent against single targets. In Vietnam, countless sorties (with dozens of resultant prisoners of war) were used to destroy single bridges near Hanoi. Today one aircraft can destroy multiple individual targets in

Figure 5. The Terminal High Altitude Area Defense Weapon System (THAADTM) is a key element of the Ballistic Missile Defense System (BMDS). THAAD will provide rapidly deployable ground-based missile defense components that deepen, extend and complement the BMDS to any combatant commander to defeat ballistic missiles of all types and ranges while in all phases of flight. THAAD's combination of high-altitude, long-range capability and hit-to-kill lethality enables it to effectively negate the effects of WMD at intercept ranges well beyond the defended area.

a single pass. And General Norman Schwarzkopf's famous "Left Hook" attack across the trackless desert in western Iraq during Desert Storm would not have been possible without full, integrated use of GPS.

At the same time, GPS has become a global utility, igniting commercial enterprise worth $30 billion annually to the US economy. Today the evolution continues as the Air Force competes GPS III to improve warfighting capability and stay ahead of America's adversaries.

As a pair of USAF F-16s scramble, two missiles are launched nearly simultaneously from the terrorist redoubt. A Space Based Infrared System (SBIRS) satellite on silent sentry in geosynchronous orbit detects the launches. Pertinent data is downlinked to SBIRS Mission Control, which characterizes the launch plumes to calculate the trajectories and impact points of the outbound missiles. Estimated enemy missile launch points are relayed to the special operations team, and the missile trajectories are forwarded to the THAAD batteries.

But the asymmetrical advantage AFSPC forged in space will not go unchallenged. Witness the recent Chinese anti-satellite test. Such challenges were foreseen by Air Force space leadership, so creation of AFSPC begat creation of US Space Command, now STRATCOM, to develop a combatant command for space. The implication is that space has become an 'Area of Responsibility" for military operations—and that combat can occur in this new domain. Space superiority is now considered equivalent to air superiority and space support to combat operations has become part of US policy, doctrine, and strategy.

As we work together with our AFSPC partner toward space superiority and the improvement of warfighting capabilities, we must appreciate that the development and deployment of new space systems involves some fundamental differences from other military procurement. The first article, when launched, must work perfectly the first time. Unlike aircraft programs, there is no extended flight test period for space systems.

Space systems are also relatively more expensive to acquire per platform because of the need for long life, incorporation of launch costs, and sophisticated technology—so any failure is felt more dearly. As a result, acquisition processes have been modified specifically for space procurement, and we have adjusted and evolved our management processes. Together, we have learned how to manage a partnership to realize acquisition success. While we have made great progress, we still understand that the partnership needs to deepen.

The F-16s approach the target area and detect laser "painting" of the missile launchers by the special operations team. Three Maverick air-to-ground missiles are sent on their way and three launchers and their crews are destroyed. Meanwhile, THAAD radars lock on to the two incoming warheads. Two interceptors are launched. Both seekers acquire their targets, and the warheads are obliterated. Back in the high desert, the special operations team moves in to survey the destroyed launchers, secure the area, and collect useable intelligence. A chopper is summoned and they return safely to base. Whether they thought about "space" is not known, but it is clear they had the right tools at hand to do the job.

Over the past 25 years, the AFSPC has revolutionized the way we think about space and utilize "this new ocean," as President John F. Kennedy called it, to protect our nation. Emphasis on the warfighter has brought into sharp focus the necessity of fielding a team of well-honed space professionals—in government and industry alike—who understand not just the advanced systems they develop, but the environment in which they are employed, and the way to make them most useful at the point of the spear.

The men and women of Lockheed Martin Space Systems are proud to be a part of that team, and we congratulate the Air Force Space Command on 25 years of serving the warfighter.

Ms. Joanne M. Maguire (BS, Electrical Engineering, Michigan State University; MS, Engineering, University of California at Los Angeles) was appointed executive vice president of Lockheed Martin Space Systems Company in July 2006. She served from July 2003 as vice president and deputy of Space Systems Company. Previously she also served as the company's vice president, Special Programs, focusing on sensitive national security space system developments.

Prior to joining Lockheed Martin, Ms. Maguire served as deputy and vice president of Business Development for TRW Space & Electronics (S&E), now Northrop Grumman Space Technology. In addition to sharing the S&E CEO's general management duties, she led the business development function, overseeing strategy formulation, program development, marketing and communications, technology development and discretionary investment.

Previously, Ms. Maguire was vice president and general manager of S&E's Space & Laser Programs Division, leading developments for NASA space systems and international satellites as well as laser systems. Before that, she served as vice president and general manager of S&E's Space & Technology Division, and as deputy general manager of S&E's Defense Systems Division, which managed national security space systems activities. Earlier, Ms. Maguire led TRW's Defense Support Program. She joined TRW in 1975.

The Elements of Successful Military Transformation:
Applying Lessons Learned from Science, History, and Corporate America

Dr. Michael F. Stumborg
Toffler Associates

The American military use of space has undergone a number of technological changes in the past half-century. Political changes—both global and domestic—required accompanying adjustments, and sometimes a dramatic transformation, in the organizational structures required to exploit the asymmetric military advantages afforded by space. The creation of Air Force Space Command (AFSPC) was in fact one such transformation.

The dynamic nature of the adversaries confronted by American military space pre-eminence means that transformation may be a constant companion of the military space community for the foreseeable future. Air and space leaders must understand the dynamics of transforming organizations for competitive advantage. One could argue that the "Art and Science of Military Transformation" should become a core competency for anyone aspiring to a leadership role in the American military space community.[1]

Beginning the Search

Where should the aspiring leaders of tomorrow look to build their competencies in the Art and Science of Military Transformation? Many of the most useful lessons come from successful endeavors outside the military realm. Western science, mathematics, and the physical sciences in particular, form the foundation of so many of humankind's advances that they can provide a foundation for understanding military systems, and thus military transformation as well. Historical examples of "scientific transformation" exist (the helio-centric solar system and quantum mechanics), but our focus here is on the *tools* provided by science to describe the military activities and institutions we wish to transform.

Emulating past experiences is another schoolhouse for the student of military transformation. As George Santayana said, "Those who cannot remember the past are condemned to repeat it."[2] But there are certainly desirable outcomes from the past that are worthy of emulation. History, ancient and recent, military and not, is the only repository of transformational case studies where organizational theory meets the laboratory of reality.

And finally, there is the business world—especially American-style free market capitalism. Militaries may conduct wars, and prepare for future wars in between, transforming along the way for current and anticipated adversary actions, but corporate America is *always* on a belligerent footing. Newcomers, small and nimble, constantly challenge large companies, established and dominant, who must transform or die. Carl von Clausewitz noted the analogies between war and commerce in *On War*.[3] They are too powerful to ignore here.

Unfortunately, simply unearthing and copying successful instances of transformation from history or business, or blindly applying the tools of mathematics and science, is not sufficient. Inappropriate application of these powerful enablers to the study of military transformation may result in failed transformation and the dire consequences that accompany such a failure in the high stakes competition of modern warfare. We must understand and avoid the limitations and misapplication of these techniques before employing them.

Lessons from Science

It is axiomatic that we cannot, without great difficulty, transform that which we cannot measure, and we cannot measure that which we cannot describe and model faithfully. Transforming military forces and the organizations that support them is most easily accomplished if we can model those forces and organizations, their relationships, and how they work together to produce large outcomes. Clausewitz, and no doubt many others before and since, probably looked upon the deterministic nature of Newtonian physics with great envy. What military commander would not want the ability to observe the enemy for just a short time and subsequently predict their future movements with high certitude?[4]

Clausewitz' adaptation by analogy of Newtonian ideas to warfare is instructive, and has been required reading for generations of military theorists. His work, though admirable, is at best an attempt to force-fit warfare into a mathematical construct with no hope of completely describing it accurately. The bad news is that Newtonian physics is linear, and warfare is decidedly non-linear. Hence the Clausewitzian insurance policies of "chance" and "friction." The good news is that today, just as the number of problems that succumb to Newton's linear models is decreasing, our understanding of non-linear mathematics, and our access to virtually infinite computational power, is increasing. Military theorists, and the military organizational (transformation) theorists that support their missions have increasingly more accurate and appropriate models of warfare

“Rising rates of change thus compel us not merely to cope with faster flow, but with more and more situations to which previous personal experience does not apply.” ~ Alvin Tofler

and of organizational behavior. Identifying and applying the elements of successful military transformation will likewise require a greater and deeper understanding of these “new sciences.”

Charles R. Darwin observed: “It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.” Darwin’s observation is just as applicable to manmade organizations, like the AFSPC, as it is to the natural organisms he encountered in the Galapagos Islands. In fact, the equal applicability of Col John Boyd’s observe, orient, decide, and act (OODA) Loop to both organisms *and* organizations makes this analogy even stronger: “The OODA loop can be compared with the genetic reproduction cycle of organic species. Instead of genes, an organization passes on ideas, orientation, and action repertoires from one to the next cycle, discarding those orientation patterns and actions that appeared to be dysfunctional. Like organisms, according to Boyd, armed forces compete, learn, evolve, survive, or not.”[5] This analogy is useful to the student of military transformation so long as we understand that genetic processes are slower and more incremental. Where Darwin dealt with *evolutionary change,* today’s successful military organizations must more often than not deal with *revolutionary transformation* if they are to adapt and survive. Transformation must often deal with smaller numbers of generations and the intergenerational exchange of much larger bits of “genetic material.” The analogy between evolution (a very successful theory, and thus worthy of imitation), and military transformation is powerful, but not perfect.

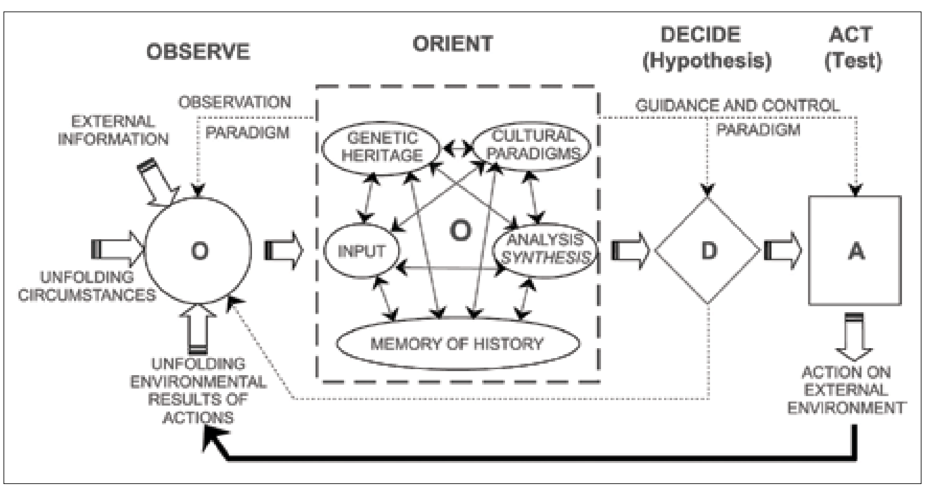
Lessons from History

History shows that our most adept future adversaries may be those who studied and understood how the United States defeated previous foes. In a like manner, victorious generals who insist on “fighting the last war” just one more time, are apt to lose when faced by an adaptive enemy, even a recently “defeated” one.[6]

But the *accelerated pace of change* brought about by information age warfare requires that we abandon all but analogous ties to Darwin’s natural world. True, strength and intelligence are indispensable ingredients to military victory, but a less informed and weaker force can often compensate for these shortcomings with speedy adaptation to the tactics of the superior force. The accelerated pace of change in warfare (and all forms of Information Age competition) must therefore concern the military transformation practitioner greatly.

History has many examples of successful military transformation that we can use to guide our transformational activities today. Transformation is the subject of numerous books and military journal publications.[7] Just so long as the history being made today unfolds slow enough that these past examples remain applicable, we are justified and safe in replicating them.

At what point do the examples of history become irrelevant? We are reminded by Alvin Toffler in *Future Shock* that “Rising rates of change thus compel us not merely to cope with faster flow, but with more and more situations to which previous personal experience does not apply.”[8] Combine this observation with another from *War and Anti-War* that “The way we make war reflects the way we make wealth,” and an ominous future where historical lessons are less relevant seems to be just over the horizon.[9] During the Agriculture Age wealth derived from the Earth, the implements of war were similar to the implements of the field, and change occurred over the course of centuries. In the Industrial Age, wealth derived from possession of superior “land, labor, and capital.” In the age of the factory, warfare became likewise industrial in nature—massed armies, mass production, and weapons of mass destruction—and change occurred over the course of decades. Now in the Information Age, wealth creation and warfare have changed again, and changes occur yearly, if not monthly. The pace of change is indeed accelerating. The span of relevant history is likewise decreasing. Should we reach an era where changes in warfare become instantaneous, then history could become much less relevant. It is thus more important today than ever, for the practitioner of military transformation to be cognizant of the fact that the lessons learned from history may not be as applicable as we have come to believe.



The OODA Loop is a concept originated by military strategist Col John Boyd of the USAF. Its main outline consists of four overlapping and interacting processes: Observe, Orient, Decide, and Act.

Lessons from Corporate America

Even business leaders recognize this accelerated pace of change. Multiple speakers at a recent Davos World Economic Summit "expressed the sense that history was accelerating and time was being compressed."[10] Warfare is not the only form of Information Age competition where the ability to transform oneself is the key to victory. The modern gladiators of the corporate world are, like militaries, engaged in a form of competition that requires them to observe, orient, decide, and act repeatedly in order to dominate their markets. Like militaries, corporations must repeatedly transform to survive. Again, like militaries, corporate transformations occur on multiple time scales. British Petroleum is already looking "beyond petroleum" in anticipation of the energy markets several decades hence. At the other end of the spectrum, magnetic (and now optical) storage media for computers, and the companies that manufacture them, arise, dominate, and fall into disfavor, in just a few years if they fail to adapt to new technologies and consumer tastes.[11] Westinghouse started out making air brakes for locomotives and transformed itself several times to make products as diverse as light bulbs and nuclear weapons.

Organizational transformations occur all around us all the time in both the government and private sectors. Transformation's crucial role in organizational success (and in the extreme, organizational survival) makes it a popular topic in business and military journals. Multiple authors have applied the teachings of military strategists as diverse as Sun Tsu, John Boyd, Carl von Clausewitz, and Ghengis Khan to the business arena. The reverse—applications of business principles to warfare—are more difficult to find, but may provide valuable lessons nonetheless to the practitioner of military transformation. Because commerce and warfare are both forms of competition described by the Boyd OODA Loop, it is not surprising that the elements of successful military transformation appearing in military books and journals are strikingly similar to the elements of successful business transformation appearing in business journals.[12] The caution applied to the analogy between science and military transformation, also applies here: The analogy between the elements of successful business and military transformations are powerful, but not perfect.

So What?

Transformation is a top-down affair in hierarchical organizations. Transformation, fundamental change, requires a set of leadership competencies derived not just from the study of military history and business successes, but also from an unwavering commitment to understanding the potentially rapidly changing environment and adapting to that environment while preserving organizational effectiveness. Space forces must adapt as the Air Force adapts to ready itself for the future. Leaders will comprehend those changes, adjust to them, and preserve the many dominating advantages that space forces bring to Joint forces. Failing to do that is not an option.

Conclusion

Transformation is a critical enabler of future victory in war and should therefore be a core competency of the modern military officer. These military officers can derive great insight into this subject, and thus their own ability to execute and lead transformation by studying certain aspects of science, history, and business. Ensuring that lessons from these disciplines are not misapplied to military transformation initiatives requires a reasonably in-depth understanding of them.

Notes:

1 Or, for that matter, a leadership position in any military, or similarly competitive community.

2 From *Reason in Common Sense*, sometimes quoted alternatively as "Those who cannot learn from history are doomed to repeat it."

3 Carl von Clausewitz, *On War*, Penguin Classics; Abridged Ed edition (November 18, 1982)

4 As Newton was able to approximate with the celestial bodies for example.

5 Frans Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd*, 170.

6 The French did defeat Germany in the World War I, but their embrace of the Maginot Line, and the German adaptation to *Blitzkreig* led to the opposite result very shortly thereafter.

7 See for example, Williamson Murray and Allan R. Millett, eds., *Military Innovation in the Interwar Period* (Cambridge University Press, 1996; or Stephen P. Rosen, *Winning the Next War* (Cornell University Press, 1994); See for example Michael F. Stumborg, "Air Force Space Command 2005–A Transformation Case Study," *Air and Space Power Journal*, XX, no. 2 (Summer 2006).

8 Alvin Toffler, *Future Shock*, (Bantam Books, December 1991).

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10 Jonh Thornhill, "The view of the future from Davos world economic forum," *Financial Times*, London Edition, 31 January 2006.

11 Clayton M. Christensen, *The Innovator's Dilemma*, ch. 9, Harvard Business School Press, Boston, MA, 1997.

12 Stumborg, "Air Force Space Command 2005" (2006).

Dr. Michael F. Stumborg (BS, Physics, Illinois State University; PhD, Physics, The Catholic University of America) is a senior consultant at Toffler Associates where he assists government and commercial clients in their strategic planning and change management efforts, to include recent support to the Air Force Space Command's Commanding the Future initiative.

Prior to coming to Toffler Associates he worked for the US Navy in various assignments ranging from basic research in materials science to technology-enabled concept of operation development for the chief of Naval Operations' Strategic Studies Group, and as a science advisor to both the Navy director of Antiterrorism and Force Protection and the director of the Naval Criminal Investigative Service.

Dr. Stumborg is a veteran of the US Army.

20th Air Force Developing 21st Century Strike Planners

Lt Col Andrew S. Kovich
Commander, 90th Maintenance Operations Squadron

As more and more space and missile personnel are deploying to the Combined Air and Space Operations Center in Southwest Asia, arming these troops with a solid foundation in strike planning is essential. Fortunately, Air Force Space Command (AFSPC) has a numbered air force (NAF) with a long tradition of force application planning—20th Air Force (20 AF). As the NAF with the preponderance of space/missile operations officers (Air Force Specialty Code [AFSC]: 13S) and missile maintainers (AFSC: 21M), 20 AF is in a unique position to not only develop solid nuclear operations/maintenance skills, but also to educate nearly 75 percent of all new 13S accessions and a large number of 21M officers on strike planning and force employment tactics. In 2005, General Lance W. Lord, USAF, retired, then commander of AFSPC, underscored the importance of these skill sets when he said:

> "There is no better skill to have as a space professional than a complete and comprehensive appreciation for nuclear operations. It teaches us all the meaning of "bombs on target." It gives us our "Warrior Ethos," and it has been pivotal in transforming our command from a research and development background to an operational Major Command in our great Air Force."[1]

The purpose of this article is to educate the AFSPC community on the intercontinental ballistic missile (ICBM) strike planning process, its similarities to the joint air tasking cycle (JATC), and finally to advocate for increased study of this skill-set by our personnel. To accomplish this task, the article will first discuss the "big picture" of the ICBM strike planning process as part of the nuclear planning process. Next, a description of specific people, processes and products involved in both the JATC and the ICBM strike planning process will expose our ICBM personnel to the detailed procedures required to place bombs on target, on time. Finally, a description of current 20 AF initiatives will highlight ongoing efforts being made to educate our ICBM operators, maintainers, and security forces personnel in this area.

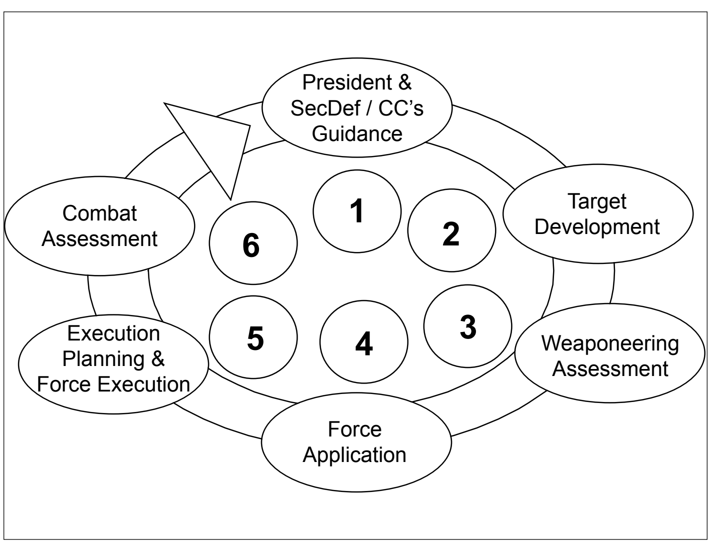


Figure 1. Nuclear Planning Process.

Nuclear Planning Process

The Nuclear Planning Process (figure 1) is a six step process beginning with "guidance and priorities issued by the president, secretary of defense, and chairman of the Joint Chiefs of Staff and culminates with the final step of combat assessment."[2] The six phases of the process include: (1) President, secretary of defense and commander's guidance outlining objectives and intent to initiate the planning cycle; (2) Target development, validation, nomination, and prioritization focuses on adversary centers of gravity for attack; (3) Capabilities analysis results in a weaponeering assessment describing expected results to include target sets and consequences of execution; (4) Commander's decision and force assignment matches specific weapons systems to targets; (5) Mission planning and force execution consists of the tasking order, unit preparation and presidential authorization to execute; and, (6) Combat assessment determines whether military objectives have been achieved."[3] This six-step process is similar to other planning processes such as the JATC and is the basis for ICBM Strike Planning.

The nuclear planning process is useful for missile personnel to understand because it is not unlike the JATC or the ICBM strike planning process and thus provides a solid base from which to relate to other USAF operations.[4] Now that a baseline understanding of nuclear planning has been established in general, a more detailed review of JATC follows so we have a solid planning foundation before specifically discussing ICBM processes.

Joint Air Tasking Cycle[5]

The JATC (figure 2) accommodates Joint Force Commander (JFC) guidance, changing tactical situations and requests for support from other component commanders. This section discusses the overall JATC concept and the six steps of the JATC by highlighting the divisions/teams within the Air Operations Center (AOC), as well as the products delivered in order to execute joint air operations. The JATC begins when the Joint Force Air and Space Component Commander (JFACC) receives the campaign objectives from the JFC.

Step 1: Objectives, Effects, and Guidance. Step one of the JATC is carried out by the Strategy/Plans Team within the Strategy Division of the AOC. Using the Joint Air Estimate Process (JAEP), the Strategy Division first conducts a mission analysis to identify the key questions of who, what, where, when, why for the air plan.[6] Airpower courses of action (COA) are then developed followed by COA analysis and comparison. Once a COA is selected, the Strategy/Plans Team writes the Joint Air Operations

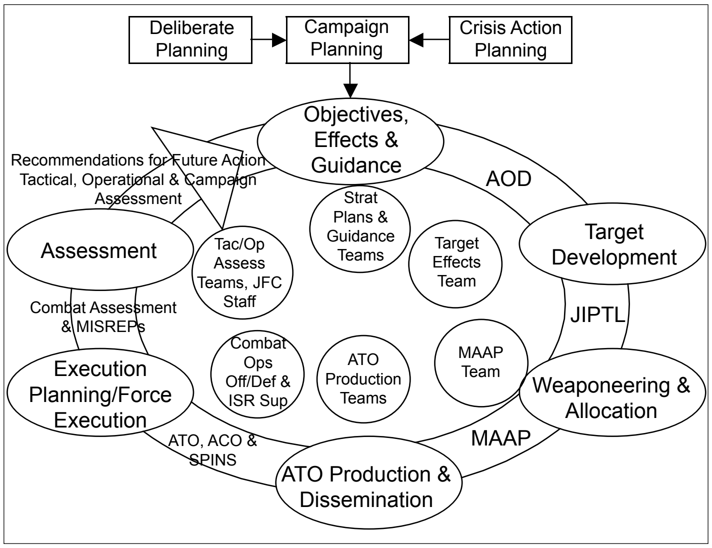


Figure 2. Joint Air Tasking Cycle.

Plan (JAOP). The JAOP contains the situation, mission (JFACC intent), air operations (operational objectives), logistics and command and control sections. The purpose of the JAOP is to directly support the JFC's campaign objectives and recommend air apportionment. Apportionment is the percentage of effort devoted to various air operations for a given time. For example, at the outset of an air campaign, the weight of effort would be higher in the offensive counterair category due to the need to gain/maintain air superiority in order to conduct follow-on air operations. Once apportionment is approved by the JFC, the Strategy/Plans Team produces the Air Operations Directive (AOD). The AOD provides the directive for how airpower will achieve JFC objectives and its completion marks the end of step one.

Step 2: Target Development. Target Development begins when the Target Effects Team (TET) in the Combat Plans Division receives the AOD. Using the tactical air objectives outlined in the AOD and the approved apportionment percentages, the TET builds the joint integrated priority target list (JIPTL) based on target nomination lists provided by each of the components (air, land, maritime, special operations). The targeting/battle damage assessment team of the intelligence, surveillance, and reconnaissance division also participates in this step by providing products for target development. Since all components are represented in the AOC, liaisons typically coordinate at this step of the process. If there is a conflict with the JIPTL, the Joint Target Coordination Board (JTCB) will decide where forces will be used. Results of the JTCB are then incorporated into the JIPTL. Once the JIPTL is approved by the JFACC/JFC, it is forwarded to the Master Air Attack Plan (MAAP) Team.

Step 3: Weaponeering and Allocation. Step three begins when the MAAP Team receives the JIPTL. The MAAP Team is part of the Combat Plans Division and is responsible for weaponeering and allocation. While apportionment determines the weight of effort applied to each air power function, allocation assigns specific platforms and weapons to strike targets. The key products of this team are the MAAP worksheets, MAAP brief and sortie allocation information. This step is complete when the JFACC approves the allocation of forces as outlined in the MAAP brief.

Step 4: ATO Production and Dissemination. Step four is conducted by the Air Tasking Order (ATO) Production Team of the Combat Plans Division. The ATO Production Team takes the MAAP data and puts it into the ATO format. The ATO is the tool that tasks and executes day-to-day air operations and the goal of this step is to provide the ATO to operational units 12 hours prior to mission execution. Additionally, the ATO Production Team produces the airspace control order to deconflict aircraft and friendly fires as well as any special instructions (SPINS) to supplement the ATO. Once the ATO is delivered to the units, step four is concluded and execution can begin.

Step 5 and 6: Execution Planning/Force Execution and Assessment. Steps five and six are focused on monitoring execution of the ATO and assessing its effectiveness. Step five is performed by the Offensive and Defensive Operations Teams within the Combat Operations Division. These teams monitor the execution of air operations and compile combat assessments, bomb damage assessments, and mission reports. These assessments/reports are then forwarded to the Operational Assessment Team for step six. The Operational Assessment Team of the Strategy Division conducts operational assessments to determine if alternate COAs or apportionment changes are needed. Steps five and six are as important to the cycle as the first few steps because they include opportunities for components to provide input to the process. Additionally, the outcomes of assessment result in recommendations for the next AOD which will restart the JATC. It should be noted that the strike planning process for ICBMs uses a similar methodology to the JATC and the Joint Space Tasking Order (JSTO) process as well.[7]

ICBM Strike Planning Process

The ICBM Strike Planning Process (figure 3) also uses a six-step process and consists of guidance, target selection/desired ground zero (DGZ) construction; allocation, application, timing/deconfliction; Joint Plan Interim Change (JPIC) production/distribution; mission plans; and, assessment, wargaming/analysis. Like all planning processes, the ICBM process begins with guidance from senior leaders.

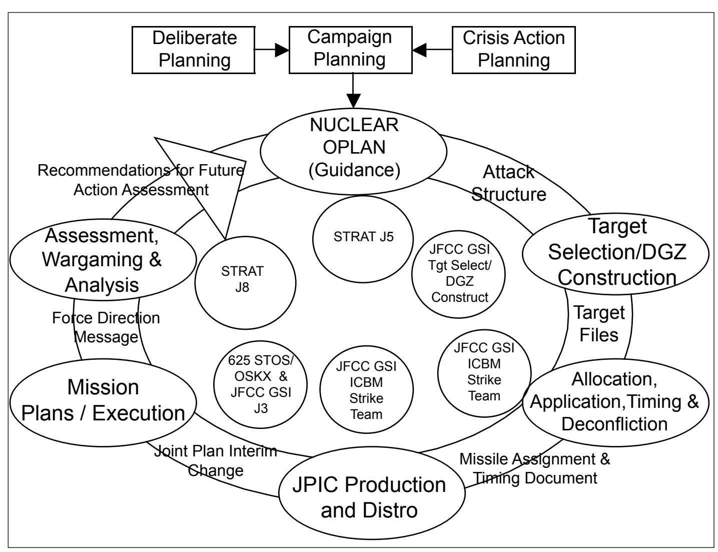


Figure 3. ICBM Strike Planning Process.

Step 1: Guidance. Step one of the process is the policy developed to guide the employment of nuclear weapons. Nuclear guidance begins with the president and is refined by each lower echelon ultimately ending with the commander, US Strategic Command (CDR USSTRATCOM) guidance to operation plan (OPLAN) planners. Nuclear guidance at the presidential level is codified in a presidential directive. The presidential directive is issued by the president, incorporates the advice of the National Security Council, and provides the broad policy objectives for US nuclear forces. Upon receipt of these presidential directives, the Department of Defense focuses the guidance into military employment objectives. The secretary of defense produces the Policy Guidance for the Employment of Nuclear Weapons which provides objectives, targeting philosophy, and constraints. This guidance is in turn refined by the CJCS in the form of the Joint Strategic Capabilities Plan nuclear supplement (JSCP-N). The JSCP-N provides nuclear warplan direction to USSTRATCOM for OPLAN development. Finally, the nuclear OPLAN is the result of the planning efforts of the USSTRATCOM Plans and Policy Directorate (J5) and the USSTRATCOM Joint Functional Component Command, Global Strike and Integration, Plans and Integration Directorate (JFCC GSI/J5) and is directly supported by the six nuclear task forces assigned to USSTRATCOM.[8] Task Force 214 (20 AF) is the task force with direct control over ICBMs. All actions taken by strike planners are in direct support of this plan. Once specific OPLAN objectives are codified, intelligence personnel and targeting experts begin the process of analyzing enemy centers of gravity for attack.

Step 2: Target Selection DGZ Construction. The JFCC GSI Target Selection Division and the DGZ Construction Branch in the JFCC GSI Plans division are the key players involved in step two. The nuclear OPLAN directs a specific attack structure be designed to prosecute numerous conflict scenarios. Step two of the planning process is related to target selection and DGZ construction. Target selection is the process by which USSTRATCOM planners distill the list of hundreds of thousands of worldwide targets identified by the intelligence community into a more manageable list of prioritized installations to be planned against to fulfill OPLAN requirements.[9] Enemy centers of gravity that may be likely targets for nuclear strikes include "military forces, military bases of operation, infrastructure supporting those forces; command and control systems and nodes, and weapons of mass destruction storage facilities, delivery systems and deployment sites."[10] Once the target list is compiled, aim points are identified for every type of weapon in the nuclear arsenal. In the nuclear targeting business, these aim points are known as DGZs.[11] DGZs are "planned locations on, above, or below the Earth's surface, where a weapon is to be detonated to achieve the optimum/allowable result."[12] The goal of this step in the process is to build DGZs that will allow the designated weapon to achieve a desired level of damage expectancy (DE).[13] DE (figure 4) is determined by multiplying the probability of damage (PD) and the probability of arrival (PA) for a given weapons system. PD is determined by calculating the weapon yield, accuracy (CEP), height of burst (HOB), target characteristics (VNTK) and desired level of damage.[14] PA is calculated by multiplying pre-launch survivability (PLS), weapons system reliability (WSR) and probability to penetrate (PTP).[15] WSR and PLS are planning factors provided to USSTRATCOM by the commander, AFSPC as required by the JSCP-N.

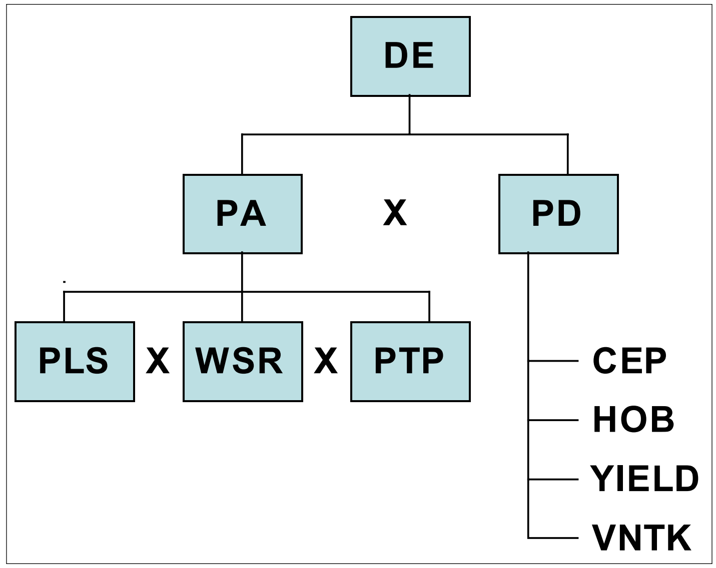


Figure 4. Damage Expectancy.

AFSPC A3 Nuclear Operations Branch (AFSPC/A3NN) develops planning factors from information in the Weapons System Effectiveness Report produced by the 526th ICBM Systems Wing, Hill AFB, Utah, and approved by the Chief, Nuclear and Helicopter Operations Division (AFSPC/A3N).[16] The OPLAN outlines the required DE for specific target sets based on objectives. Depending on attack objectives, the strengths and weaknesses of a weapon system are assessed to determine the best weapon for a given mission. The product produced at step two is the individual target files which equate to the JIPTL in the JATC. ICBM planners then begin the process of allocating and then applying weapons to targets in order to meet OPLAN objectives.

Step 3: Weapon Allocation/Application/Timing and Deconfliction.[17] Allocation is the process by which the best weapon is selected for a target. "Each system has advantages and disadvantages … such as range, weapon yields, lead time, accuracy, recallability, and vulnerability to enemy defense systems."[18] USSTRATCOM planners receive inputs from their service components on the number of assets available for nuclear tasking. For ICBMs, AFSPC provides USSTRATCOM with the Forces Available document that communicates the number of boosters and reentry vehicles (sorties/weapons) that will be available for planning. In turn, USSTRATCOM balances all other service inputs to determine their needs for a given weapon system. The result of this determination is distributed to all nuclear forces in the Force Commit document that outlines USSTRATCOM requirements for a given system and directs compliance with the USSTRATCOM Priority Maintenance Letter (PML) and the OPLAN.[19]

Ensuring the nuclear force is capable of meeting the objectives of a diverse attack structure is the goal of the ICBM Strike Team planner in USSTRATCOM's JFCC GSI. Maintaining the viability of the attack structure begins with sortie availability requirements. Based upon these requirements, the ICBM strike planner balances intelligence generated targeting requirements with missile unit sortie maintenance schedules. As a result, the planning process at USSTRATCOM can be initiated by a number of different factors. Intel updates on target sets can drive a change but most often the sortie modification schedule necessitates the need to retarget a sortie off of a high priority target to a lower priority target while the maintenance modification occurs.

Weapons systems require periodic maintenance to assure full mission capable status of the platform. In addition, modifications to extend the service life or to improve reliability, accuracy, or timeliness of launch, are accomplished continuously through a weapons system's life cycle. As a result, modifications sometimes require the missile to be removed from strategic alert to accomplish required retrofit. Maintenance modification requests are submitted in the form of a JPIC request letter.

The JPIC request originates in the unit Maintenance Operations Flight Plans and Scheduling Section and is then passed to the unit Weapons and Tactics Flight (OSK) Plans Section for review. Following OSK review, the request is submitted to 20 AF who provides a second review before sending to the ICBM Strike Team (JFCC GSI/J541) in the "Air Room" at USSTRATCOM. At this point, planners begin to determine how they will cover the target set allocated them based on current sortie availability.

ICBM Strike Team planners utilize the Missile Graphic Planning System (MGPS) to plan ICBM strikes. Once the planner determines where the sortie is required to be targeted to meet national guidance, the MGPS software allows the planner to assign individual weapons on specific sorties to a specific DGZ. MGPS then provides the capability to "fly out" the sortie to determine range and re-entry vehicle footprint ability. A sortie's footprint is defined as the weapon's physical ability to fall within an ellipse on the ground given factors such as re-entry angle, distance to target, and speed. Essentially, planners apply and reapply weapons as necessary to account for all required targets and cover planned sortie maintenance. Planners then time the targeted sorties against all other existing missions in the overall OPLAN attack (ICBMs, submarine-launched ballistic missiles, and aircraft weapons). This portion of the process is essential to integrate specific attack options and to prevent fratricide of friendly weapons. Once the missions are successfully timed, planners perform an internal quality check (QC) to ensure sortie capabilities are optimized and are planned according to guidance. An example of planning guidance is the requirement to use an alert weapon or a survivable weapon for a particular target. Additionally, requirements for a specified level of damage or for collateral damage constraints could be identified. Once the Strike Team has performed a QC on their target package, the targeting is submitted to another Air Room agency to perform a second QC to ensure all required OPLAN targets are covered and in compliance with guidance. The product delivered at this step of the process is the Missile Assignment and Timing (MAT) document. The MAT is similar to the MAAP and contains every ICBM's assignment in the war plan.

Step 4: JPIC Production and Dissemination. The ICBM Strike Team produces JPICs for each sortie/mission being targeted or requiring a targeting change. A JPIC is the only authority to change the alert category or targeting of an ICBM. JPICs include information related to sortie configuration, attack structure, target locations and time-on-target requirements. Two planners verify all JPICs, and one final QC planner reviews JPICs to ensure this data is correct before delivery to 20 AF's 625th Strategic Operations Squadron Weapons and Tactics Flight Plans Section (625 STOS/OSKX) for mission planning and transmission to the field.

Step 5: Mission Plans and Execution. The 625 STOS/OSKX performs the final verification of targeting information by matching the targeting received from the Air Room with the JPIC request originally submitted to the ICBM Strike Team by 20 AF/A3NK. Next, 625 STOS/OSKX uses actual missile guidance set gyroscopic data to "fly" the targeting data provided by the strike team since MGPS only uses a facsimile of the minuteman operational targeting program. When 625 STOS/OSKX has "good flys" and all targets are within parameters, OSKX releases the targeting data via a Force Direction Message (FDM) directly to launch control centers for use by missile combat crews on alert. The Rapid Execution and Combat Targeting (REACT) weapons system provides missile combat crews the ability to rapidly retarget sorties by providing an interface between the Strategic Automated Command and Control System and the weapons system computer. Instead of manually inputting all target and execution plan information into the weapons system computer, the crew simply transfers the information contained in the FDM from the Higher Authority Communication side of the REACT console to the Weapons System Control Element. This capability eliminates the laborious process of typing sortie configuration data (Propulsion Replacement Program [PRP], Guidance Replacement Program [GRP], number of re-entry vehicles [RVs], RV type), RV re-entry angles/spacing, target latitude/longitudes, attack option assignments, delay times, and country codes into the weapons system by hand. The Remote Data Change Targeting procedure is then accomplished to provide the sortie with the authorized targeting data. The same targeting data sent to missile combat crews is also transmitted by the ICBM strike team to unit OSK planners in JPIC formats.

USSTRATCOM's JFCC GSI Global Operations Directorate (J3) is responsible for command, control, and execution of nuclear forces. Day-to-day, the current operations section is responsible for monitoring the daily viability of the war plan. Specifically, they track sortie alert status and how off-alert sorties degrade execution options. The JFCC GSI's Global Operations Center (GOC) is responsible for global situational awareness and is the mechanism for exercising operational command and control of the nation's global strategic forces. The GOC's Emergency Action Team is responsible for transmitting directives to the alert force. "Based on Presidential orders, the GOC will execute global strike missions or send emergency action messages to the strategic nuclear forces."[20]

Step 6: Assessment, Wargaming and Analysis. Step six is performed by the USSTRATCOM Capability and Resource Integration Directorate (J8) and ensures that "target effects are consistent with either the strategic or the theater campaign objectives. Combat assessment is composed of three interrelated components: battle damage assessment, munitions effectiveness assessment, and reattack recommendation."[21] In conventional planning, a mission is executed and then evaluated for effectiveness so guidance can be changed to improve the planning process. Combat assessments following a nuclear strike are equally important. During this assessment, intelligence data is collected on the enemy to determine if the desired effects of the attack were achieved. "If possible, combat assessment will be required to include estimates of environmental impact, including radiological contamination of soils, water, and air, as well as contamination carried from the target."[22]

In peacetime, the assessment process for nuclear planning is ongoing to ensure viability of the OPLAN for execution. This assessment occurs during simulations and wargames. For nuclear forces, a rigorous process using analysis tools is used to assess attack effectiveness at a given time. Enemy air defenses are just one example of the type of threats evaluated during a simulated execution of the war plan. Computer modeling is used to "determine if the required target effects are being achieved … consistent with the JFC's campaign objectives."[23] Now that we understand the process used by USSTRATCOM, let's drill down to the unit level for a description of the day-to-day process.

Day-to-Day Planning

The plans and scheduling section in the maintenance group precipitates the primary need for day-to-day sortie retargeting. The large number of Minuteman III non-aligned modification programs currently being implemented by AFSPC necessitates extremely close coordination between the maintenance Plans and Scheduling Section and the OSK Plans Section in the Operations Group. In order to provide USSTRATCOM with the most capable/reliable assets, modification programs, rather than off-alert sorties, have become the priority for wing maintenance efforts. The primary modifications impacting sortie availability include: the GRP to replace portions of the missile guidance system to increase the reliability and maintainability of the weapons system; the PRP to replace the propellant in the first three stages and some hardware components; the Propulsion System Rocket Engine (PSRE) to replace components of the post-boost vehicle and modernize support equipment; and, the Safety Enhanced Reentry Vehicle (SERV) to replace some of the older Minuteman re-entry vehicles with newer, safer, and more reliable warheads. Additionally, government mandated Re-entry System Limited Life Component changes and other re-entry system configuration changes based on the Moscow Treaty are recurring maintenance requirements.[24] Balancing all of the sustainment and modernization programs with other mandated requirements demands meticulous planning on the part of every player in the planning process.

The following is a typical scenario for how the planning process is initiated by a needed sortie modification in the field. A sortie at FE Warren AFB, Wyoming requires a missile remove and emplace to upgrade the sortie to a PRP/GRP/SERV configuration. Notionally, it takes 14 days to perform this maintenance action—a day to teardown (remove re-entry system and post-boost control system), a day to pull the missile, approximately 10 days to perform maintenance required without a missile/warhead present, a day to emplace the missile downstage and a day to buildup (install re-entry system and post-boost control system) the sortie.[25] For this action to take place, maintenance scheduling determines the total number of days required to be utilized and requests relief from priority OPLAN assignments. However, this determination is complicated by uncontrollable events such as weather, road closures, personnel availability, security requirements, or the inability to get necessary parts or equipment. Once all these factors have been accounted for, OSK forwards the request to 20 AF who in turn sends the request to USSTRATCOM. Typically, these scheduled actions occur 45 days prior to the needed targeting. The ICBM Strike Team then begins building a monthly targeting package for the entire ICBM fleet (all unit requests included).

So, why is understanding this process and each unit or individual's role important to ICBM professionals? Because educating our Airmen on the whole system, rather than just their individual pieces, is a necessary step to ensuring the ICBM team can continue to meet emerging threats with the most reliable nuclear weapon platform while undergoing historic levels of retrofit and modernization. All in all, these actions fulfill the AFSPC vision by being the "acknowledged experts and leaders in fielding, launching, and employing space power for the 21st century."[26] Learning the ICBM system will in turn lead to developing airmen capable of understanding other USAF processes or systems in use throughout any combatant command they find themselves in the future.

Warfighting 101

In last year's AFSPC's *High Frontier*, Maj Gen Thomas F. Deppe, commander, 20 AF, highlighted the importance of educating 20 AF personnel on ICBM operations, weapons, tactics, and planning. In his article, he called all 20 AF personnel "missileers" and described the benefits of the "Warfighting 101" education when he said:

> "This education will not only create nuclear weapons system experts, but personnel who have the ability to relate to the bigger Air Force and who have the skills required to take other space disciplines to the next level of warfighting capability. Whether it is launch procedures, sortie generation or securing Priority A resources, missileers must have the basic knowledge to relate ICBM skill sets to the entire MAJCOM and the Air Force as a whole."[27]

Since last year's article, 20 AF has made great strides in creating programs that will bring this vision to reality. Specific 20 AF programs underway to ensure this education occurs include the writing/publication of the first-ever ICBM tactics, techniques, and procedures (TTP) volume, the development of an Advanced ICBM Course, and the initiative to place space weapons officers into 20 AF units. Together, these three endeavors are very important steps toward creating nuclear experts and educating 20 AF personnel on planning/tactics skill sets.

In 2005, 20 AF/A3NK began writing an ICBM TTP in conjunction with AFSPC/A3NN and the ICBM Strike Team at USSTRATCOM. The intent of the TTP is to allow "new personnel to immediately gain access to generations worth of expertise."[28] The ICBM TTP differs from most USAF 3-series TTP volumes (such as tactical employment of the F-16) in that it provides more strategic level information. "The nature of the ICBM business dictates this volume to be more educational than employable at the crew level because tactics are applied at the [combatant command] COCOM level."[29] However, the volume does contain many techniques designed to better employ the weapons system.

The ICBM TTP volume consists of seven chapters and two attachments. Chapter one provides an introduction and general overview of weapons system safety rules, crew resource management, and how ICBMs contribute to the air and space power functions of counterair, countersea, counterspace, counterinformation, counterland, and strategic attack. Chapter two provides the reader a basic understanding of the Minuteman III weapons system. ICBM operations, maintenance, and security forces processes are discussed in addition to launch procedures and weapons effects. Once this description of ICBM fundamentals is accomplished, the volume begins to delve into ICBM planning and tactics. Chapters three through six provide descriptions of Minuteman III capabilities/limitations, system threats, planning processes, and ICBM employment tactics.[30] Chapter seven covers crew techniques and maintenance procedures. These techniques/procedures are designed to ensure efficient operations and will be the most dynamic aspect of the document in that changes to techniques/procedures will be continuously updated to improve operations and maintenance processes. Finally, the ICBM TTP includes attachments containing a glossary of terms and graphics depicting ICBM minimum and maximum ranges dependent upon sortie configuration. To teach these TTP concepts to the ICBM force, 20 AF/A3NK created a course to improve both emergency war order procedures and provide advanced ICBM concepts to personnel previously not privy to this information.

The 20 AF Advanced ICBM course was instituted in 2006 with the goal of educating every officer in all unit OSKs on ICBM planning and tactics skill sets not typically learned until the senior O-3/junior O-4 timeframe by personnel assigned to USSTRATCOM. Over the past year, attendees from ICBM security forces and maintenance were included in the course to facilitate integration of all facets of the nuclear business. As the ICBM TTP stated, "20 AF has the opportunity to teach officers valuable information in the first six years of their career that took their superiors 15-plus years to experience first hand."[31] The Advanced ICBM Course capitalizes on this opportunity and serves as both an ICBM familiarization and an introduction to nuclear policy, planning, and tactics.[32] The most recent course held at Offutt AFB, Nebraska attended by operations, security, and maintenance personnel was highly successful. 20 AF should continue to deliver this course on no less than a quarterly basis. Additionally, technical blocks of instruction on ICBM propulsion, guidance, and re-entry systems should be included in future courses. To ensure these skill sets are effectively presented to the ICBM community, 20 AF has also executed a plan for producing system experts to help teach the concepts.

The most recent initiative carried out by 20 AF was to send ICBM officers to the Space Tactics Instructor Course at the USAF Weapons School at Nellis AFB, Nevada. The objective of this initiative is to return fully trained weapons officers to the ICBM community. These weapons officers will use their expertise in critical thinking, instructor skills, and understanding of the USAF flying culture of open, honest, and direct feedback in crew training to facilitate the education of the ICBM force. Additionally, weapons officers will provide operations expertise to initiate improvements. One such improvement would be the implementation of the debrief process by 20 AF crews. The debrief process is a technique used by air crews to critically think through actions and identify root causes of mistakes made in operations in order to make improvements to TTPs. Additionally, Weapon School graduates will be charged with integrating different aspects of the ICBM community. For example, the weapons officer could implement ICBM familiarization programs at the unit level to ensure operations, maintenance and security forces personnel have a complete understanding of the nuclear business as a whole. In total, the 20 AF initiatives created to distribute this information not only provide a better educated ICBM force, but also teach valuable skills that personnel leaving 20 AF can apply in any other weapons systems they may operate.

"The Minuteman III ICBM is the USAF's primary nuclear global strike system capable of projecting decisive air and space power worldwide in a matter of minutes."[33] As a result, a thorough understanding of the processes and techniques discussed in this article are extremely valuable to professionals in AFSPC. Greater knowledge of these concepts "will not only produce officers with better skill sets for the nuclear business, it will produce officers ready to apply operations, planning and tactics skill sets to the next space weapons system."[34] Moreover, the initiatives taken by 20 AF to distribute this information will not only benefit those in the ICBM business but also AFSPC and the joint community. "The benefits to this endeavor include: providing experts for unit OSK shops within 20 AF; providing planning experts to other AFSPC mission areas; providing a knowledgeable pool of officers for USSTRATCOM duty; providing 13S officers who can talk planning Air Force-wide; and ability to contribute in conventional planning shops and other joint billets critical to Air/Space Integration within the Department of Defense."[35]

Notes:

[1] General (USAF, retired) Lance W. Lord, "Strategic Deterrence: Evolving Our Mindset and Capabilities," speech, 20 April 2005.

[2] Joint Publication (JP) 3-12, Joint Doctrine for Joint Nuclear Operations, Final Coordination, 15 March 2005, xi.

[3] Ibid., xi.

[4] Ibid., II-4.

[5] AFOTTP 2-3.2, Air and Space Operations Center, 13 December 2004, 1-12.

[6] JP 3-30, Command and Control for Joint Air Operations, 5 June 2003, III-4. The JAEP process is a six-phase process used to produce the JAOP. The six phases are: (1) Mission Analysis—consists of intelligence preparation of the battlespace (IPB) and analysis of JFC mission/guidance to produce the air component mission statement. (2) Situation and course of Action (COA) Development—possible enemy COAs and enemy/friendly centers of gravity (COG) are analyzed. Additionally, multiple air COAs are developed. (3) COA Analysis—friendly COAs are war gamed against enemy COAs. (4) COA Comparison—friendly COAs are evaluated against each other to determine effectiveness. (5) COA Selection—COA recommended to JFC. (6) JAOP Development—selected COA is developed into JAOP.

[7] In the STO process the joint space operations plan (JSOP) and space operations directive (SOD) are produced by the Strategy Division and equates to the JAOP and the AOD. The Combat Plans Division Target Effects Team is responsible for Target Development and the production of the Target Recommendation List (TRL). The Joint Space Effects Team performs deconfliction and produces the Joint Master Space Plan (JMSP). The JSTO Production Team produces and disseminates the Joint Space Tasking Order (equivalent to the ATO). The Combat Operations Division is responsible for executing the current JSTO and receiving unit reports. The Strategy Division conducts combat assessment and produces the Combined Assessment Report.

[8] Nuclear task forces include: Aerial Refueling/Tankers (TF294), Airborne Communications (TF124), Ballistic Missile Submarines (TF134 and TF144), Strategic Bomber and Reconnaissance (TF204), Land-based Inter-

continental Ballistic Missiles (TF214).

[9] Nuclear OPLAN targets are selected from tens of thousands in the Modernized Integrated Database (MIDB) and form the National Target Base (NTB) from which options are generated.

[10] JP3-12, II-5.

[11] A DGZ is similar to either a Desired Mean Point of Impact (DMPI) or a Desired Point of Impact (DPI) in conventional targeting. The DoD Dictionary of Military Terms as updated March 2007 provides the following definitions of DMPI, DPI, and aimpoint: DMPI—"A precise point, associated with a target, and assigned as the center for impact of multiple weapons or area munitions to achieve the intended objective and level of destruction. May be defined descriptively, by grid reference, or by geolocation." DPI—"A precise point, associated with a target, and assigned as the impact point for a single unitary weapon to achieve the intended objective and level of destruction. May be defined descriptively, by grid preferences, or geolocation." Aimpoint—"A precise point associated with a target and assigned for a specific weapon impact to achieve the intended objective and level of destruction. May be defined descriptively (e.g., vent in center of roof), by grid reference, or geolocation." DoD Dictionary of Military Terms, http://www.dtic.mil/doctrine/jel/doddict/

[12] AFTTP 3-1.ICBM Tactical Employment Minuteman III ICBM, 19 March 2007, 5-6

[13] A target's vulnerability to nuclear weapon effects is characterized by a VNTK classification. The vulnerability number or VN portion of the classification refers to the target's vulnerability to blast damage. The "T" in the classification refers to either target sensitivity to overpressure (P) or dynamic pressure (Q). The "K" factor of the VNTK classification refers to a target's response to a 20 kiloton blast.

[14] PTP: A calculated probability of arrival at the target, considering only the effects of enemy defenses along the route. WSR: The probability of a scheduled weapon arriving in the target area and detonating as planned excluding the effects of enemy action. PLS: The probability that a delivery and/or launch vehicle will survive an enemy attack under an established condition of warning.

[15] AFTTP 3-1.ICBM, 5-12

[16] WSR information is determined by using Olympic Play weapons system testing, Force Development Evaluations (FDE), and Simulated Electronic Launch (SEL) results.

[17] JP3-12.1 Joint Doctrine for Theater Nuclear Operations, 9 February 1996, I-3.

"Weapons available for nuclear planning include: gravity bombs deliverable by dual-capable aircraft (DCA) and long-range bombers; the Tomahawk Land Attack Missile/Nuclear (TLAM/N) deliverable by submarines; cruise missiles deliverable by long-range bombers; submarine-launched ballistic missiles (SLBM); and intercontinental ballistic missiles (ICBM). These platforms provide CDR USSTRATCOM with a wide range of options."

[18] JP3-12.1, vi

[19] AFTTP 3-21.2 Munitions and Missile Maintenance, 30 December 2005, 7-3. "The PML is a letter that identifies specific missiles assigned to high priority targets which must receive priority in maintenance scheduling."

[20] USSTRATCOM, fact sheet, January 2007, http://www.stratcom.mil/fact_sheets/fact_goc.html.

[21] JP3-12, II-5.

[22] JP3-12.1, IV-6.

[23] Ibid., III-6.

[24] US Department of State, "Treaty Between the United States of America and the Russian Federation On Strategic Offensive Reductions" fact sheet, 24 May 2002, http://www.state.gov/t/ac/trt/18016.htm#14. "On May 24 [2002], President George W. Bush and President Vladimir Putin signed the Moscow Treaty on Strategic Offensive Reductions. Under this Treaty, the United States and Russia will reduce their strategic nuclear warheads to a level of 1700-2200 by 31 December 2012, a level nearly two-thirds below current levels."

[25] The post-boost control system (PBCS) consists of the propulsion system rocket engine (PSRE) and the missile guidance set (MGS). Examples of maintenance performed when a missile/warhead are not present include: silo modifications or periodic maintenance to accomplish write-ups that cannot be performed with explosives present and include but are not limited to the environmental control system modification, drain line modification, fast rising B-plug installation, and Rivet Mile tasks.

[26] AFSPC, fact sheet, http://www.afspc.af.mil/library/factsheets/factsheet.asp?id=3649.

[27] Maj Gen Thomas F. Deppe, "Why America Needs ICBMs: Contributing to Air and Space Power and Strategic Deterrence," *High Frontier* 2, no. 4 (August 2006), 12.

[28] AFTTP 3-1.ICBM, 1-1.

[29] Ibid., 1-1.

[30] The ICBM TTP describes 14 employment tactics: (1) Multiple strikes on a single target; (2) CEP/MRT offset angles; (3) Attacking dense target areas (attack laydown geography); (4) Multiple DGZ targeting; (5) Employ penetration aids; (6) Employ nuclear effects; (7) Suppression of enemy air defenses (SEAD) for cruise missile/bomber penetration; (8) Hardened Deeply Buried Target (HDBT) attack; (9) Leveraging ("flipper sorties"); (10) Deploy Airborne Launch Control System (ALCS); (11) Single flight/Emergency combat Capability; (12) Annual code change; (13) Layering weapons for PA/PD; (14) Combined tactics

[31] AFTTP 3-1.ICBM, 1-1.

[32] The April 2007 course at Offutt consisted of four days of instruction. The familiarization portion included: USSTRATCOM, AFSPC, and 20 AF mission briefs and a history of the Minuteman III weapons system brief. Additionally, briefs on helicopter and security support were given. USSTRATCOM tours were also included as part of the familiarization. The tours included: the Airborne Command Post, Global Operations Center and the Air Room. Finally, blocks of instruction were presented on nuclear weapons effects, ICBM employment tactics, the ICBM Strike Planning Process, and nuclear policy.

[33] AFTTP 3-1.45, 1-1.

[34] Deppe, 12.

[35] AFTTP 3-1.ICBM, 1-1.

Lt Col Andrew S. Kovich (BS, Bowling Green State University, MS, Central Michigan University, MMOAS, Air University) is the commander, 90th Maintenance Operations Squadron, F. E. Warren AFB, Wyoming. During his career, he has held a wide variety of leadership positions in space/missile operations and maintenance. He served as an ICBM crew commander, crew instructor, senior standardization/evaluation crew commander, maintenance flight commander, space operations flight commander, chief, standardization/evaluation, and operations officer. He also served on the US Strategic Command and 20th Air Force staffs as an ICBM strike planner, policy/doctrine officer, executive officer, and chief, Emergency War Order Plans and Procedures.

As a missile combat crewmember, Colonel Kovich won "Best Minuteman/Peacekeeper Crew," "Best Overall Crew," and the Blanchard Trophy for "Best Missile Operations Squadron" at the Guardian Challenge Space and Missile Competition. Colonel Kovich is also the only space/missile officer to lead three separate operations crews to Air Force-level honors. He led Air Force Space Command's Missile Crew of the Year and is the recipient of the Air Force Association's Thomas S. Power Award for the "Most Outstanding Missile Crew in the Air Force" for 1995.

In 2000 and 2001, he led AFSPC's best space crew to winning the Air Force Association's "Best Space Operations Crew of the Year Award." As an ACSC student, Colonel Kovich received the 2005 General Carl A. "Tooey" Spaatz Award for Best ACSC Paper on the Advocacy of Air Force Aerospace Power. Colonel Kovich is a graduate of Squadron Officer's School, Air Command and Staff College, and the Air War College (non-resident). He is a credentialed space professional earning the Command Space Badge and the Senior Missile Maintenance Badge. Colonel Kovich is the author of "USAF Relevance in the 21st Century: A First-Quarter Team in a Four-Quarter Game," published in the July-August 2006 edition of *Military Review.*

US Air Force Academy Department of Astronautics Space Programs

Col Martin E.B. France, Lt Col Timothy J. Lawrence, Lt Col Ralph A. Sandfry, Lt Col David D. Swanson
United States Air Force Academy

The goal of the US Air Force Academy (USAFA), Colorado Springs, Colorado, Department of Astronautics is to help the Academy produce the world's finest Air Force officers who live the core values and understand space by focusing on three main areas: faculty, curriculum, and facilities. With a strong academic heritage in astrodynamics, spacecraft control systems, and space mission analysis and design, the department has evolved to become a center for innovative undergraduate space education. Today's Astro Department teaches an introductory course to all cadets, offers majors in astronautical engineering and space operations, and provides unique senior capstone design and operations courses that present future space professionals with the opportunity to 'Learn Space by Doing Space."

First and foremost, the Astro Department depends on its faculty and staff members (active-duty officers and enlisted personnel and civilians) to serve as role models for cadets, teaching officership, citizenship, and integrity by example. To accomplish this, the department must actively recruit and maintain a faculty that is current, skilled, and experienced in astronautical engineering, systems engineering and space operations fields, and Air Force operations, and can teach those subjects to all cadets at the appropriate level within a friendly, cohesive, productive, and professional environment. Classes are taught in small sections to ensure personalized instruction and a focus on learning. Upper division class sizes average less than 15 cadets per section and the average size of the core, introductory course is 20 students.

The Astro curriculum meets Air Force needs for officers with an understanding of astronautical and systems engineering and space operations via an externally validated and nationally recognized academic program in astronautical engineering and systems engineering (space systems option). All cadets, regardless of their chosen major, learn space fundamentals through the core course entitled Introduction to Astronautics (Astro 310), usually taken in their first-class (senior) or second-class (junior) year. Cadets who choose to major in Astronautical Engineering will take Astro 310 in their third-class (sophomore) year in preparation for in-depth study of the subject. By the time each cadet completes his or her 40 lessons (three semester hours) of Astro 310, they can:[1]

- Apply derived astrodynamics equations and solution algorithms to solve restricted two-body problems to describe orbital motion, define orbital parameters, develop methods of orbit determination, investigate orbit transfers and plane changes, solve satellite rendezvous problems, and generate ground tracks;
- Demonstrate understanding of the basic concepts involved in spacecraft subsystems, including control, communications, electrical power, thermal, structures, and propulsion;
- Demonstrate understanding of the basic concepts involved with launch vehicles, the launch and re-entry environments, and ballistic missiles; and
- Combine all the knowledge and skills learned in the class to complete a group-based preliminary design of a generic satellite constellation needed to successfully support an Air Force mission.

Learning is also reinforced by seven computer laboratory demonstrations and exercises where each cadet uses Satellite Toolkit, a software tool, to demonstrate and visualize a variety of space missions and maneuvers.

The major in Astronautical Engineering is the broad application of science and engineering to aerospace operations. Special emphasis is placed on astrodynamics, aerospace systems design, and control systems, preparing the graduate for Air Force duty with specialization in research, design, development, and analysis of space technology and aerospace avionics. Cadets who successfully complete the major are awarded the degree of Bachelor of Science in Astronautical Engineering, which is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The program operational goals of the Astronautical Engineering Program are to prepare cadets to become Air Force officers who:

- Possess a fundamental knowledge in astronautical engineering;
- Can communicate effectively;
- Work effectively with others;
- Are committed to lifelong learning;
- Can apply their knowledge and skills to frame and solve Air Force engineering problems, both well- and ill-defined; and
- Know their ethical and professional responsibilities as embodied in the US Air Force core values.

Upon successful completion of the Academy program in

Astronautical Engineering, cadets will be able to:

- Use fundamental knowledge of orbital mechanics, space environment, attitude control, telecommunications, space structures, and rocket propulsion to solve astronautical engineering problems;
- Plan and execute experimental studies and formulate sound conclusions, analyzing empirical data;
- Apply modern technology tools to solve astronautical engineering problems;
- Communicate effectively using oral, written, graphical, and electronic format;
- Recognize the ethical and professional responsibilities of Air Force officership and the engineering profession;
- Work effectively as a member of a multi-disciplinary team;
- Recognize the benefits of and possess the skills needed to engage in lifelong learning; and
- Informatively discuss the impact of engineering on present-day societal and global contemporary issues to include Air Force Aerospace capabilities and requirements.

The Academy and the Department of Astronautics achieve the above-listed program operational goals and outcomes by adding the following course of study to the already rigorous and broad USAFA core curriculum of over 100 hours of basic science, humanities, social, science, engineering, and physical education courses:

Math 243	Calculus III
Math 245	Differential Equations and Matrices
Math 346	Engineering Math
Engr Mechanics 320	Dynamics
or Physics 355	Classical Mechanics
Engr Mech 330	Static Analysis of Structures
Engr 341	Linear Systems Analysis and Design
Engr 342	Linear Control System Analysis and Design
Astro 201 or Comp Sci 211	Technology Skills for Astronautics
Astro Engr 321	Astrodynamics
Astro Engr 331	Space Vehicle Systems Design I
Astro Engr 351	Rocket Propulsion
Electrical Engr 447	Communications Systems I
Astro Engr 445	Spacecraft Attitude Dynamics and Control
Space Environment Option	Choice from a list of basic science courses
Astro Depth Option	An additional course within the Astro Dept
Astro Systems Engr Design Options	One of two, two-semester capstone designs

The department also administers the multi-disciplinary Space Operations major that prepares cadets for a career in the Space and Missile Operations career field. The major is designed to develop Air Force officers with a technical background in space and an understanding of contemporary problems and issues unique to space. Course work in science, geography, mathematics, and astronautics provides the technical background required for this field. Coupled with courses in space history, law, policy, and military doctrine, this program provides the breadth of education required for this growing field. The Space Operations major also provides the student with excellent preparation for entering a graduate program in Space Systems or Space Operations.

In addition to the above-mentioned core curriculum, cadets majoring in Space Operations take the following courses:

Astro Engr 331	Space Systems Engineering
Geography 382	Remote Sensing and Imagery Analysis
Operations Research 310	Systems Analysis
Systems Engr 301	Systems Engineering II
Military Strategic Studies 382	Air, Space, and Information Power Theory
Military Strategic Studies 485	Space Operations and the Warfighter
Political Science 465	US National Space Policy and Law
Physics 370	Upper Atmospheric and Geo-Space Physics
History 376	History of Space Power
Space Operations 360	Space Mission Operations Fundamentals
Space Operations 461	Space Mission Operations I
Space Operations 462	Space Mission Operations II
Space Operations Specialty	Choice of three, two-semester sequences in space chemistry, space physics, or graduate school preparation

The Astronautics department also supports the Academy's Systems Engineering major by providing a space systems track. Cadets choosing this path select from a series of Astro courses to provide depth to their broader, systems-focused program.

Of special note, within the curriculum for all three of the described majors are the innovative and award-winning capstone design courses that all cadets majoring in Astro, Space Ops, or Systems Engineering (Space Track) take. FalconSAT, FalconLAUNCH, and Falcon Operations (FalconOPS) provide hands-on experience to cadets mentored by space and acquisition professionals on the faculty that, in large part, mirror the duties these future space leaders will face once commissioned. All three courses also provide opportunities for cadets in other majors across the Academy curriculum to provide their expertise while learning about real-world research, development, acquisition, and operations within a multi-disciplinary team.

FalconSAT

Beginning in Academic year 1995-1996, the USAFA Space Systems Research Center (SSRC) began the FalconSAT small satellite program. This Department of Astronautics, two-semester capstone design course provides a realistic design experience for senior cadets majoring in Astronautical Engineering, Systems Engineering, Systems Engineering Management, and other disciplines. A cadet team, mentored by a multidisciplinary group of faculty members, apply systems engineering processes to design, build, test, and fly a small satellite performing real Department of Defense (DoD) missions. The goal for the program is to provide a "hands-on" educational experience for cadets, while applying a high level of practical engineering to solve real-world problems. Currently, the program emphasizes developing a basic capability to fly small Air Force and DoD scientific and engineering payloads on three-year cycles.

In the Spring of 2002, the Department of Astronautics and its SSRC started work on FalconSAT-3. Learning many valuable lessons from the FalconSAT-1 and FalconSAT-2 experiences, the emphasis shifted to building a solid, continuing program rather than focusing on a single mission. The SSRC focuses on cadets "learning space by doing space." A commercial-off-the-shelf set of spacecraft bus components providing power, communications, and data handling was adopted from Space Quest Ltd., Fairfax, Virginia, to provide an out-of-the-box solution for critical components, freeing cadets and faculty to focus on payload, structure, and attitude control systems development. Working with the Academy Physics Department, two important space environment experiments were chosen as payloads: Flat Plasma Spectrometer (FLAPS); and Plasma Local Anomalous Noise Experiment (PLANE). FLAPS will characterize the effects of non-Maxwellian charged particles on formation, propagation, and decay of ionospheric plasma bubbles. FLAPS will also contribute to the validation of the plasma bubble and radio wave scintillation measurement and forecasting system associated with DoD's Communication/Navigation Outage Forecasting System. PLANE will identify and characterize spacecraft-induced plasma turbulence. A third payload, Micro Propulsion Attitude Control System (MPACS), developed by Air Force Research Laboratory's (AFRL) Propulsion Directorate at Edwards AFB, California, will establish system space flight heritage and quantify the change in momentum caused by this low-thrust, electric pulsed plasma system, with a thrust of 150 micro Newtons, an Isp of 800 seconds, and an input power of 4 W. Cadets briefed these experiments to the DoD Space Experiments Review Board in November 2002 where they were ranked 18 (MPACS), 31 (FLAPS), and 36 (PLANE) of 47 among all space experiments DoD-wide.

Figure 1. View of FalconSAT-3. The satellite (18"cube, 119 lbs.) uses passive (gravity gradient boom) and active (magnetorquers) attitude controllers located inside the satellite.

Cadets finished a conceptual design review of FalconSAT-3 in May 2002. At that time, the team decided to follow the Russian approach of building three satellites per mission: engineering model; qualification model; and flight model. This approach would give each cadet class a significant deliverable/milestone every year with a plan of completing a new mission every three years, while allowing the cadets to experience "hands-on" assembly, integration, and test. It would also reinforce the importance of documentation, since each cadet class must pass their work to the next class—approximately 30 senior class cadets take the course each year. Finally, it would significantly reduce program risk by avoiding last-minute integration and testing issues, which lead to scheduling and budget woes for many space programs.

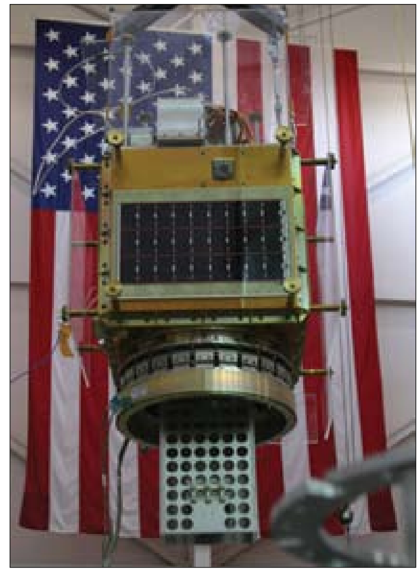
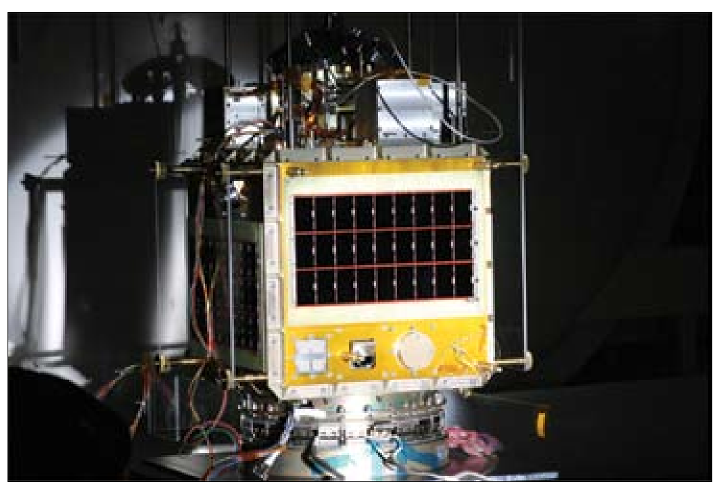


Figure 2. FalconSAT-3 with Lightband, Shock Ring, and Gravity Gradient Boom (in stowed configuration). The boom stabilizes the satellite so FLAPS and PLANE can take accurate measurements.

In Spring 2004, cadets built a full-scale Engineering Model (EM) of FalconSAT-3, including a gravity gradient boom. A team of cadets traveled to Kirtland AFB, New Mexico, for two weeks in February of that year to conduct complete EM environmental testing, including temperature cycling in a thermal/vacuum chamber and vibration testing to many times expected launch g-levels. The results validated the basic structural and systems design for the satellite. Starting in Fall 2005, cadets built a full-scale Qualification Model of FalconSAT-3, followed by the Flight Model, which was ready for launch by August 2006.



Figures 3. FalconSAT-3 during thermal vacuum and vibration testing.

Figure 4. Cadets, working with lab technicians, carefully integrate the many parts of FalconSAT-3, to include the Lightband, a mechanism that will release the satellite from the launch vehicle payload adapter into its final orbit.

In October 2006, the cadets passed their flight readiness review with flying colors. The review was attended by several senior Air Force and DoD officials, as well as representatives from Boeing and Lockheed Martin. On 1 December 2006, FalconSat-3 began its journey to Kennedy Space Center (KSC), Florida, in a storage container designed to protect the satellite while allowing cadets and faculty to monitor its health (mainly battery charging).

Cadets and faculty deployed to KSC in several supporting waves. The first wave conducted satellite functionality tests to prepare the satellite for launch and worked with Boeing contractors to integrate FalconSAT-3 to the Atlas V's secondary payload adaptor ring on 7 December 2006. The remaining waves performed final battery charging and support launch operations.

On 9 March 2007 FalconSAT-3 was launched aboard a Lockheed-Martin Atlas V as a secondary payload on the Space Development and Test Wing's STP-1 mission. The Centaur upper stage and evolved expendable launch vehicle secondary payload adaptor ring successfully inserted FalconSAT-3 into its final orbit 560 kilometers above the Earth, 66 minutes after lift-off. The FalconOPS team is now in the process of commissioning the satellite. Five crews consisting of four cadets and a faculty mentor communicate with FalconSAT-3 several times a day, checking the health of the systems. Fully satellite commissioning will require 36 passes over the ground station. During these passes, each subsystem will carefully be turned on and tested, to make sure the launch did not damage the satellite and that each component is working properly—a process spanning several weeks. After validating all systems operations, the satellite will begin to collect scientific data using the FLAPS and PLANE sensors. These data will then be passed to the Physics Department for analysis. FalconSAT-3 is expected to operate on orbit for at least 12 months, providing valuable data to the USAFA Department of Physics, AFRL, and other DoD agencies. The lessons learned from the development, construction, testing, launch, and operation of the FalconSAT-3 will provide excellent, real-world experience for the next generation of Air Force space leaders, and set the stage for future small satellite development at the USAFA. In fact, that follow-on work has already begun.

Conceptual design of the SSRC's next satellite, FalconSAT-4, began in January 2005 with a symposium at which 25 different possible payloads were presented by a variety of industry, government, defense, and academic organizations. Cadets completed the conceptual design in December 2006 and briefed their design to Mr. Gary E. Payton, deputy under secretary of the Air Force for Space. Unfortunately, funding for FalconSAT-4 was cut shortly thereafter. AFRL, however, came to the rescue with funding and a new small satellite concept, and the cadets and staff began design work on FalconSAT-5.

Currently manifested for a Fall 2009 ride on board a Minotaur IV launch vehicle, FalconSAT-5 is scheduled to carry the following payloads: Wafer-Integrated Spectrometers (WISPERS) to measure ions resulting from an AFRL-provided ion source to validate USAFA and AFRL/PR plume models; SmartMESA (Miniaturized ElectroStatic Analyzer, with organic memory and processing) to detect the temperature and density of ambient ions to validate ionospheric data assimilation models; and AFRL Ion Source characterized by SmartMESA and WISPERS; and an radio frequency uplink signal strength meter to characterize very high frequency signal distortion to improve ionospheric models.

The FalconSAT-5 preliminary design review was conducted in May 2007, again briefed to Mr. Payton, and a structural engineering model validated the dynamic characteristics of the design in vibration testing conducted at AFRL/VS, Kirtland AFB. Cadets in the Class of 2008 will continue FalconSAT-5 development, maturing the design through critical design review during Academic Year 2007-2008 and building a Qualification Model of the satellite for additional testing and validation. The Class of 2009 will build the flight model of FalconSAT-5, which will (hopefully) be launched and operated by cadets in the Class of 2010.

FalconOPS

The FalconSAT program's innovative approach to immersing cadets in a development environment enhances their understanding of complex acquisition programs and exposes them to the processes, timelines, and challenges space professionals face every day. In 2003, the Department of Astronautics recognized that an operational dimension of FalconSAT should also be integrated to the curriculum. At USAFA, operations are considered the art and science of taking a complex mission, breaking it into its component parts, and building standardized elements that together, make the mission execution routine, reliable, and repeatable. While space operators make use of highly technical equipment, their focus is on how people fit into and succeed with the mission. For instance, with the launch of the FalconSAT-1 vehicle in January 2000, the program had an austere ground station but no formal process to flow cadets through training and operations in the facility. There needed to be a program that supported FalconSAT. That program became FalconOPS.

During the two-year stand-down of the shuttle fleet following the Columbia tragedy, cadets in the space operations major re-evaluated their role in FalconSAT. To that point, space operators took their place alongside astronautical engineering, management, computer science, and systems engineering majors in FalconSAT. In 2002, USAFA made three pivotal decisions that accelerated the Academy's dominance in pre-commissioning space education and training; modifying the space operations major to better prepare cadets for a career in the space community; "operationalizing" the ground station; and integrating space into all cadets' USAFA experience.

The Department of Astronautics had offered space operations as a major since 1982. The major was based on the astronautical engineering program and, at one point, had the highest total hour requirement of any major at USAFA. This made the degree a highly technical, non-engineering program that appealed to a limited number of cadets. In an attempt to better prepare space operations graduates for a career in the space community, the major was "tuned-up" when USAFA looked at a survey of space professional competencies conducted by Booz, Allen and Hamilton in 2002. The survey pointed out that USAFA graduates needed knowledge of space science, programs and organization, development and acquisition, mission areas, value of space, system design, policy, doctrine, law, systems architecture, sustainment, information technology, workforce management, operations environment, testing, planning, training and evaluation, modeling and simulation, and support infrastructure. To provide graduates with these competencies, the major's curriculum was altered significantly in 2005. The most significant change was to replace the two, four-semester-hour astronautical engineering capstone courses with three, three-semester-hour space operations courses. Cadets are now involved in FalconSAT in the spring semester of their second-class (junior) year and are able to speak to the first-class cadets involved in the program before they graduate. The result was a reduction in the loss of corporate knowledge in the program, and the creation of a cadre of cadets who specialize in space.

In 2003, the department "operationalized" its ground station. This took a highly technical program and packaged it so that non-engineers could participate. In effect, it opened the program to a wider spectrum of cadets. In the ensuing years since 2003, the ground station became the centerpiece for the space operations major. Cadets were organized into a Cadet Space Operations Squadron and they built and administered a training, evaluation, and operations program based on AFSPC's satellite command and control squadrons at Schriever AFB, Colorado. The new squadron defined operational processes, generated documentation, and managed operational crews to reduced risk to and increase the lifetime of its FalconSAT satellites.

On average, there have been six to 10 space operations majors in each class year. This was not enough to meet the need for a sustained crew force of 15-20 (e.g., FalconSAT-2 required five, three-person crews and FalconSAT-3 required five, four-person crews). Ensuring sufficient qualified crew members has been a challenge but USAFA has always found enough motivated cadets to meet the need. During the first three years of FalconOPS, training was conducted as an extracurricular activity. Underclass cadets volunteered their valuable time to complete an 18-hour training program leading to an evaluation check ride. Training was and still is conducted in a realistic environment using real satellite hardware as a simulator. After becoming certified, cadet crews work training shifts in and around their class schedules until launch day to remain proficient.

Cadets with experience in space are now transferring operational control of NASA's Gravity Probe B satellite from Stanford University, California. This $750-million satellite completed its intended on-orbit mission of gathering scientific data and was scheduled to be mothballed. Academy cadets studied the concept of bringing the mission control center to USAFA and determined that for very little investment they could do just that. Today the transfer is halfway complete. Future cadets will gain experience in FalconSAT and in the Gravity Probe B control centers.

In 2007, the training program was institutionalized. It formed the basis of a five-course sequence of Space Power Applications, Capabilities, and Employment (SPACE) training courses that are integrated into a cadet's class schedule. The courses are a component of USAFA's broader Aim Higher program designed to educate all cadets on space.

Repetition and involvement are two key ingredients to learning. USAFA offers a wide range of space experiences to achieve both. In fact, cadets "Learning Space by Doing Space" within FalconOPS allows USAFA to further integrate space into the cadet experience, exposing cadets space operations with an operational satellite control facility. The lessons they learn in the ground station are transferable to other operationally oriented career fields—conducting reliable, repeatable, preplanned activities in a time-constrained environment. The objective was to socialize all graduates of USAFA to the idea of space power, its capabilities, and limitations.

In 2003, the dean and commandant chartered the cross functional area Space Working Group and commissioned it to survey current space activities at USAFA, create a strategic plan, and integrate space throughout the Academy. The strategy recognized five strategic areas—cadets life, leadership, academics, training, and external organizations. The plan also addressed each strategic area, and FalconSAT's ground station figured prominently in this effort.

By 2006, five space training courses were approved by the curriculum review board—SPACE 251, 350, 461, 472, 473. These courses were fashioned after the highly successful airmanship programs of Soaring and Jump. Today the summer space orientation program (SPACE 251) is considered a high-priority program in which more than one third of all cadets enroll. Cadets completing SPACE 251 are considered "oriented" to space and can wear the newly approved cadet basic space badge. The sequence of SPACE courses offers cadets the opportunity to further explore increasing levels of involvement in space at USAFA. After completing SPACE 251, cadets may elect to hone their operational skills in the FalconOPS training program (SPACE 350) and become certified as crew members, earning the right to wear the cadet senior space badge. A cadet who is both certified and leads a space program can then wear the cadet command space badge.

FalconSAT-3 spacecraft, built, tested, and delivered by cadets is now on orbit and being operated by cadets. At submission of this article, cadets control the space vehicle and are in the process of commissioning its subsystems and beginning daily operations. As FalconOPS moves forward, new ground control software will be implemented preparing to operate FalconSAT-4 and FalconSAT-5, master control of Gravity Probe B, and explore the use of Academy-owned space telescopes in a space surveillance role. These activities will bring space to USAFA cadets who will then integrate its capabilities into military operations, ensuring that the US maintains its pre-eminence and secures its security.

FalconLAUNCH

The USAFA Space Systems Research Center began the FalconLAUNCH sounding rocket program in Academic year 2002-2003. This Department of Astronautics, two-semester capstone design course provides a realistic design experience for senior cadets majoring in Astronautical Engineering, Systems Engineering, Systems Engineering Management, and other disciplines. Each year, cadets apply systems engineering processes to design, build, test, and fly a solid-propellant sounding rocket. The goals for the program are to provide a "hands-on" educational experience for cadets, while applying a high level of practical engineering to solve real-world problems. Currently, the program emphasizes developing a basic capability to fly small Air Force and DoD scientific and engineering payloads on a yearly basis. Technical goals are to a design reproducible system capable of flying a 5 kg payload to over 100 km—suborbital flights to the edge of space.

With the experiences of the previous four years, this year's FalconLAUNCH V program is the most ambitious and challenging rocket design and launch in USAFA's history. The cadet team received specific technical requirements: deliver a sounding rocket and fly it to an altitude of over 45 km with a payload of at least 2.3 kg. For the first time, two payloads were selected and integrated into the avionics subsystem. A real-time video imaging system will transmit on-board video to two separate ground stations. A second payload, a Micro-Electro-Mechanical System Inertial Measurement Unit, developed by the Space and Missile Systems Center's Det 12, Kirtland AFB, New Mexico, is the program's first-ever DoD payload. To achieve these ambitious technical goals, the cadet team designed and static-fired a 3,700 lb. thrust rocket motor on the Academy grounds in March 2007. Cadet simulations of the expected trajectory predict speeds of more than Mach 5 and accelerations of more than 25 g's.

The cadet team followed a rigorous systems-engineering process to perform requirements analysis, functional analysis, and design of their system throughout the Fall 2006 semester. A series of technical reviews culminated in the system critical design review on 13 December 2006, like FalconSAT reviewed by Mr. Payton and a team of government and industry leaders who provided valuable feedback to the cadet team. The second semester included subsystem fabrication, testing, system integration, and ultimately launch in May 2007.

Figure 5. Rocket Motor Static-Fire Test.

For the first time, NASA's Wallops Flight Facility in eastern Virginia provided the launch site. This new association with the NASA Sounding Rocket Program Office brings a wealth of rocket expertise to the program. NASA engineers mentored cadets in sounding rocket design issues, and also advised cadets as they develop the necessary operational procedures, flight simulations, and range and ground safety analysis.

Cadets benefit from solving tough, practical, technical design, manufacturing, and operational issues. Early in the process, cadets learn the importance of requirements and directly experience the challenges of balancing performance, schedule, and cost. One of the most practical lessons learned is the vital role that risk management plays in successfully developing complex systems. Cadet leaders identified, early on, the key risk drivers and developed programs to control these risks. Vital or new technologies were demonstrated early, at the component level, prior to finalizing the design. One example of this was the nosecone design challenges resulting from aero-heat-

Figure 6. Cadet 1st Class Tanya Dubiel (Class of 2007) checks thermocouple leads on the nosecone test article.

ing. For the Mach 5+ rocket, the analysis and material decisions were much more difficult than past designs. To help control this risk, the cadets conducted a heating test of the nosecone tip with the aid of the 718th Test Squadron at Arnold AFB, Tennessee. The arc-heated test provided valuable technical data and led to several changes to the nosecone design.

Beyond just application of engineering and management lessons, the FalconLAUNCH team is also responsible for the logistics and operations of the rocket launch. Planning began months in advance to deploy all the necessary hardware and personnel. Cadets worked directly with NASA range and safety personnel to produce and approve all the ground processing and countdown procedures. Flight safety approvals relied extensively on the cadet flight simulations to generate the range hazard patterns. Cadets performed all the key roles of the launch operation, from vehicle integration, payload checkout, countdown, and ground station operations. Cadets functioned just like their real-world counterparts, working side-by-side, in program management, engineering, test, and operations. The experiences they gained from interacting with government and industry personnel to produce an operational system make this program truly unique.

Cadets learned tremendous lessons in systems engineering, program management, modeling and simulation, manufacturing, test, launch operations, and working together as a team. Perhaps more important, these future leaders learned much more about development of complex systems than any textbook could possibly communicate. The lessons of this program—the technical rigor, discipline, professionalism, and attention to detail—have an irreplaceable impact on these future officers as they begin their Air Force careers.

Conclusion

FalconSAT, FalconOPS, and FalconLAUNCH provide innovative, multi-disciplinary space experiences preparing USAFA cadets to become tomorrow's space leaders. The full "soup-to-nuts" experience from concept development through research, development, testing, construction, training, and operations, constitutes a truly unique undergraduate experience. Newly minted lieutenants produced by these and other complementary Air Force Academy programs stand ready to serve, applying these early lessons learned to the challenges they will face in the world's greatest air and space force.

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Notes:

[1] Astro 310 Student Handbook, Spring 2007.

Col Martin E. B. France (BS, Engineering Mechanics and Engineering Sciences, US Air Force Academy) is a professor, United States Air Force Academy and head of the Department of Astronautics. He commands the Department of Astronautics with final responsibility for curriculum, personnel, research, budget, long-range planning, faculty development, and cadet instruction. He supervises 14 Air Force officers, six civilians and a support staff of four people offering 18 college-level courses annually to educate over 1,300 cadets in Astronautics. He manages a dynamic $5 million research program funded by Air Force Space Command, Air Force Research Laboratory, and other Department of Defense organizations.

Lt Col Timothy J. Lawrence (BS, Mathematical Sciences, USAFA, Colorado; MS, Nuclear Engineering, MIT, Massachusetts; PhD, Electrical Engineering and Satellite Engineering, University of Surrey, UK; MA, Military Operations and Scientific Art, Air Command and Staff College, Alabama) is the director of the Space Systems Research Center and assistant professor for the Department of Astronautics at the USAFA. He directs one of 11 AFOSR funded USAFA research centers, conducting space technology research to design and build innovative low cost spacecraft and sounding rockets with 15 faculty from five academic departments, 56 cadets, six contractors, and three reservists under an annual $1 million budget. Colonel Lawrence is also the small satellite program director, setting goals for performance, schedule and cost to meet DoD mission objectives for three microsatellites. He directs and teaches senior level capstone courses.

Lt Col Ralph A. Sandfry (BS, Aerospace Engineering, University of Kansas; MS, Systems Engineering, AFIT; PhD, Aerospace Engineering, Virginia Polytechnic Institute and State University, Virginia) is assistant professor of Astronautics and systems division chief, Department of Astronautics, USAFA. He also serves as program director of the FalconLaunch Sounding Rocket Program. As systems division chief, he leads 10 faculty members in developing and teaching seven college-level courses in Astronautical Engineering. In directing the FalconLaunch program, he leads five faculty, three NCOs and five contractors in providing senior-level cadets an opportunity to design, build, test, and fly a sounding rocket to the edge of space. He also teaches engineering courses in dynamics, linear systems analysis and controls, and orbital mechanics.

Lt Col David E. Swanson (BS, Electrical Engineering, Southern Illinois University, Illinois; MS, Space Operations, Air Force Institute of Technology, Ohio; MS, Electric Engineering, University of Colorado, Colorado; MA, Military Arts and Sciences, Air University, Alabama) is an assistant professor of Astronautics at the USAFA in the Department of Astronautics. Colonel Swanson holds the position of advisor in charge of the Space Operations Major as such, he is principally involved in the development of three new capstone courses for the Space Operation Major. He also serves as the officer in charge of the Falcon Satellite program ground station. He is currently teaching an intermediate level course in space systems engineering while developing an USAFA wide space program called Space for All.

General Schriever Essay Contest Winner

1st Prize WINNER

To Command the Stars: The Rise of Foundational Space Power Theory

1st Lt Brent D. Ziarnick
Wing Tactics Officer, 50th Space Wing Weapons and Tactics Flight, Schriever AFB, Colorado

Predicting technical innovations in space power is a risky business. Viewers exiting theaters after seeing *2001: A Space Odyssey* in 1968 would be disappointed indeed at American space power in 2007. Even six years after the setting of the movie there are still no lunar colonies, no manned missions to Jupiter, and no orbital platforms worthy of Dr. Wernher von Braun's ringed space station. History does not bode well for those attempting to predict the future of space power in 2037. Technological development in space is full of risk both scientifically and economically. Breakthrough capabilities may not be physically possible, or may be prohibitively expensive. Fortunately, space power is not derived solely through technical means. The most important development space power could possibly achieve in the next thirty years is neither expensive nor particularly difficult to achieve and, if accomplished, may also lessen the risk of advancing space technically as well. This single, most critical development is the construction *and adoption* of a foundational theory of space power, inspired by the space environment, which can describe and prescribe *all* human activity in space. Best of all, that which is required is simply for officers of the Department of Defense's (DoD) Executive Agent for Space to embrace their medium and listen to the theorists of sea and air power which taught the correct way to view the sea and sky, the other two foreign environments mankind has conquered.

Space Power Theory and Failure of Modern Space Power

To claim modern American space power as a failure is a strong assertion. Critics would undoubtedly point to our impressive military space-based information services and our civilian human spaceflight program as counterexamples. Certainly, no other nation can come close to America's ability to operate in space. However, we must not simply compare ourselves only to our nearest competitor. As a famous military theorist said, "In spite of these splendid performances of individuals, which have led the way for the world in the development of this most important art and science, and benefit to commerce and civilization, we, today, compared to our resources and ability are falling back constantly."[1]

It cannot be argued in any honest way that, regardless of the successes of American space power today, its foundation is not tottering. The global positioning system (GPS), often touted as having the most robust constellation ever, is operating with many obsolete and degraded satellites serving far beyond their expected design life with little chance of immediate replacement. Current NASA estimates predict that the civil space organization will have no way of putting humans in space for a span of at least four years between the retirement of the Space Shuttle and fielding of the replacement crew exploration vehicle.[2] Americans walked on the Moon in 1969, but that is now beyond our capability until at least 2016.[3] In almost all areas, American space power is congratulating itself for its modern operations by living off of the heroic efforts of great Americans in the past without producing equally strenuous actions today to preserve and expand it, all the while naively assuming it will also be there tomorrow.

The deteriorating state of American space power is not primarily due to problems of technology or lack of money, it is a simple failure of will caused by lack of understanding. For its entire history space officials have believed every problem in space development is either technical or economic in nature and have paid little attention to underlying, and permanent, motives for acting in space. Military space officials especially have neglected the historical fact that maritime and aviation efforts in America were almost totally stifled until sea power and air power theory emerged to arm the zealots, educate the leaders, inspire the population, and open the coffers so that American sea and air power could emerge into their dominant form.

Though various theories of space power have been attempted with varying degrees of success, none have consciously been adopted by the DoD Executive Agent for Space.[4] Even more troubling, the most commonly accepted space doctrine in the military is the doctrine of effects, which seeks to deny or ridicule the notion of space as an environmental medium altogether:

> Thinking about space as just a location or a set of platforms is an *artificial* constraint that distracts from the whole point of launching satellites into orbit—getting the desired *effects* for the warfighter … The *primacy* of the concept of space as a set of related effects rather than a location or a set of platforms is a true paradigm shift. [emphasis original][5]

Lt Col Ed "Mel" Tomme's quest to achieve a "doctrinal change to emphasize the primacy of effects" over medium is symptomatic of an organization that has no connection to its medium, no pride, and no idea how about to proceed—all poor characteristics of the Executive Agent for Space because it assumes that space power has already reached a high level of maturity.[6] Colonel Tomme's words betray his own "artificial constraints" widely adopted in the military: the assumptions that satellites are the only set of platforms from which space power is built and information is space's only product. This lack of vision stems from the military space establishment's *modus operandi* of looking to current or near-term technology, rather than history, to answer pressing questions. Even the most visionary space leaders, in perhaps an amusing example of the observation that for Air Force officers history began at Kitty Hawk, often say space power is at the same stage of maturity as air power was in the 1920s-30s inter-war period, when it is far more likely that modern space power is really more akin to air power in 1861 with the rickety hot air balloon at the First Battle of Bull Run. The clarity required of foundational space theory cannot be found in changing technology, but in the timeless past. By adopting some of the great ideas of past military theorists, principles of foundational space power theory may emerge.

The Path to Foundational Space Power Theory—Billy Mitchell

Brig Gen William "Billy" Mitchell needs no introduction to an Air Force audience. His writings shaped the American view of air power's importance and promise to national security, but an astute reader of General Mitchell will also find that the architects of foundational space power theory will find ample sustenance there as well. Much of General Mitchell's thought on air power is also applicable to space power. Some important, but by no means complete, "maxims" of General Mitchell with potentially important implications to foundational space power theory are worth exploring.

Mitchell's First Space Maxim: *In the development of air power, one has to look ahead and not backward and figure out what is going to happen, not too much what has happened.*[7]

General Mitchell's air power theory did not constrain itself by the limitations of contemporary technology. His theory demanded heavy bombers for effective execution and consequently drove technological and aeronautical development. Indeed, if he had constrained his military air power theory to current aircraft, he probably could not have formed a coherent theory at all. Foundational space power theory must also break free from technological constraints to be effective. Space power theories based on satellites and historical space activity may be reasonably successful at adding structure to current operations but will be vastly incomplete. Space power will be advanced through technology maturation, and if space power is understood correctly insight into valuable areas of research and development would boost the return on space power investment immensely. Therefore, the proper focus of space power theory should be on the future and visualizing a truly mature space power. Foundational space power theory will accomplish both explaining a mature space power as well as lighting the path to reach it. In order to do so, it is more important to look to the future of space rather than its past.

Mitchell's Second Space Maxim: *Air power may be defined as the ability to do something in the air.*[8]

Though seemingly obvious, this statement may be the most profound words ever spoken to foundational space power theory. The power of General Mitchell's words is that they demand inclusion. Space power is not simply satellites, orbital weapons, or information dominance. Space power is anything and everything that a nation can accomplish in space. This maxim also implies that any capability in space, no matter how seemingly militarily insignificant, has value. This is so because not all strengths of space power will be able to be seen before hand, and it is very likely that space abilities derived from commercial activities will significantly enhance military space forces in ways that will not be foreseen. Space power will be part planned, part suspected, part surprising, and part undreamed of. Foundational space power theory must account for all space activity and theorists must insist that all areas of space endeavor, military and civilian, be explored.

Mitchell's Third Space Maxim: *What is necessary in this country is that the people find out the exact conditions concerning air power and the exact truth about what it can accomplish in time of peace as well as in time of war.*[9]

Mitchell's call was for America to find foundational air power theory, and through this maxim we find a precise definition for foundational space power theory. Foundational theory is nothing more than an attempt to find exact conditions and exact truth about the power at all times, in peace and in war. Truth, regardless of modern philosophical biases to the contrary, is both real and timeless. For this reason, foundational space power theory must be timeless and above short-term technological constraints. Because it must be based on firm ground to be substantive, foundational space power theory must be based on the space environment itself for its foundation. Technology is constantly changing, political constraints are constantly in flux, but the space environment is as constant in form as the sea and air, and here is the only anchor for the "truth" of space power. Only by focusing on the space environment to divine the secrets of space power's "exact conditions" and "exact truth," can theorists truly determine what space power can do in times of peace as well as in war.

Mitchell's Fourth Space Maxim: *The evidence shows plainly that the United States has adopted no modern plan of organization for meeting the general world movement in the organization of its air power. It still adheres to the methods and systems of many years ago. This has resulted in a very much retarded development of our aeronautical resources entirely out of proportion with the aeronautical capabilities of our country. We lead the world in undeveloped aeronautical material, our men make the best flyers and mechanics, our factories are capable of turning out the best airplanes, and we have all the raw materials that are necessary.*[10]

These words are addressed specifically to America, and they are as relevant today in space as they were in the air realm when they were written. Today, the United States is the dominant, but by no means only, space power in the world. This has happened because America is naturally inclined to become a space power with vast industry and academic talent, great wealth, and innovative temperament. However, like air power in the 1920s, the organization of our space effort is not conducive to space power. Our military and civil space organizations are separate with no real incentive for cooperative effort. Individual agencies offer individual visions of America in space that can co-exist and support each other, yet are virtually ignored outside their originator. Military and civil space programs build entirely separate structures and vehicles effectively creating two different government space programs with incompatible infrastructures, and perhaps most damaging, a near-total institutional indifference to each other's activities.

Foundational space power theory will understand that America's current dominant space power is a function of great potential and not concerted effort. It will demand American space power be judged against its own potential capabilities, and not against poorer or technologically inferior competitor nations. Lastly, foundational space power theory will provide a blueprint for an efficient and correct management of governmental space activities as well as explain the value of encouraging private sector space activity in all of its forms. Finally, foundational space power theory will explain that unity of purpose, not unity of control, in America's military, civil, and commercial space efforts, will unleash the true potential of the United States as a space power.

A Unified Space Effort: The Navalists

Foundational space power theory, even though intimately connected with higher policy and civilian space programs, will probably come from military circles. Historically, military thinkers have been the first to take a grand view of environmental doctrine. Perhaps the finest examples of military men explaining the military importance of civilian efforts to conquer foreign environments are the 19th century navalists, particularly Admirals Stephen B. Luce and Alfred T. Mahan. Space theorists can learn from classical sea power theory the importance of nonmilitary activity to foundational space power theory.

Navalist Space Maxim One: *Naval strategy has indeed for its end to found, support, and increase, as well in peace as in war, the sea power of a country.*[11]

Admiral Mahan was adamant in his belief that sea power was not only naval power, and not even mostly military power. He insisted the greatest military utility of sea power was a healthy and profitable sea commerce which would produce the wealth necessary to sustain a nation at war. Warships were useful in denying an enemy's "sea lines of communication" which would cripple seaborne trade and begin to strangle the target nation's economy while protecting the host nation's own, but the critical instrument of sea power is fundamentally the merchantman, not the battleship. To Admiral Mahan, naval (military) strategy was intended to expand a nation's sea power at all times, not simply military sea power. Military space strategy should be intended to produce space power in times of peace as well as in times of war, in all of its forms. Therefore, not only military space theorists, but all military space leaders must be always cognizant of civil and private space programs. More, they must be as dedicated to found, support, and increase these space programs as fervently as military programs because they are all elements of space power. Foundational space power theory must celebrate this sentiment.

Navalist Space Maxim Two: *The necessity of a navy, in the restricted sense of the word, springs, therefore, from the existence of a peaceful shipping, and disappears with it.*[12]

Emerging from the idea that sea power is fundamentally economic, Admiral Mahan describes the military sea force's role as protector of the means of gaining from the waves. Similarly, space forces should be defined as those units tasked with protecting the means of space commerce, be it electronic signals, satellites, or other spacecraft. Current "space forces" such as military communications, imagery, and navigation satellites are not military forces so much as military-owned "peaceful shipping." Military space forces consist of units capable of using force to protect or deny this peaceful shipping and designed for these purposes in mind. Again, it is seen that military space power is a secondary component of national space power which is tasked to defend the larger peaceful and economic space efforts. This is emphatically not believed today in the armed services, as space power is considered primarily military and used to support terrestrial military power. Fundamental space power theory must correct this flawed opinion and place military space forces on correct definitional and theoretical ground.

Navalist Space Maxim Three: *Of course it is obvious, a priori, to everybody that the greater the number of people existing in a particular country who are accustomed to the water in one shape or another and the more intimately they are connected with it… the larger the reserve that that country will have and the greater the development possible to its navy.*[13]

This maxim by Admiral Mahan states the importance of creating a seagoing culture, and for American space power to reach its full potential America must also encourage a vibrant spacegoing culture. With a larger number of people involved in space activity, such as spacecraft engineering, space operations, space science, and space commerce, the foundation on which national space power can be built will become strong and deep. Knowledge and mastery of space activities will become dispersed in large portions of the general population, and should the nation ever need to expand its space forces in a time of conflict or emergency it will have a great pool of competent recruits from which to choose. Also, with more minds pondering and acting upon the space question American space power will not only grow but accelerate as a larger portion of the national talent is devoted to conquering space. Foundational space power theory must convince the public that great efforts to create a spacegoing, or spacefaring, culture are both essential and attractive.

Navalist Space Maxim Four: *The reciprocal relations which exist between the military and the mercantile marine has long been recognized. The former ensures immunity from molestation of ocean borne commerce, and, in time of war, finds there its best reserves… In all history the peoples who have been most enterprising navigators, have, as a consequence, become the foremost of naval powers.*[14]

Admiral Luce here states the fundamental condition required for a nation to become the foremost power of a medium. He agrees with Admiral Mahan about the importance of both an economic and military force in the environment adding that they not only complement, but strengthen and enhance each other. In order to become a great sea power, both a navy and a mercantile marine is necessary, and by having both strong and vibrant they naturally and unceasingly sharpen each other. Space is no different than the sea in this respect. Commercial and civil space activities can be protected, and their risk lessened, by military support such as defense and search and rescue operations. Likewise, military space forces will be bolstered by a vibrant industrial base, a robust space research and development structure, and vast amounts of inherent space capabilities derived from commercial and civil space interests. By developing, and listening to, a foundational space power theory that extols both military and mercantile space programs, the United States will not only keep its military dominance in space, but will expand its space power in all forms far beyond common expectations.

Space Power Revealed

From [one] point of view, its structure appears to be simple and rudimentary; the related movements of a few principal parts are open to inspection and susceptible of criticism. But from another point of view, in its course and influence, this wonderful and mysterious Power is seen to be a complex organism, endued with a life of its own, receiving and imparting countless impulses, moving in a thousand currents which twine in and around one another in infinite flexibility, not quite defying the investigation which they provoke, but rendering it exceedingly laborious. This Power feels and is moved by many interests; it has a great history in the past, it is making a great and yet more wonderful history in the present. ~ Admiral A.T. Mahan[15]

Despite our significant forays into space, it is not yet a human environment like the land, sea, and air. Whether it is in 30 years depends primarily on America's commitment to space power. Will the people of 2037 see space tourism, moon bases, operationally responsive spacelift, manned missions to Mars, or perfectly integrated military space operations? Will space influence national security more in 2037 than it does in 2007? No one can answer for certain. However, if military space professionals study space power and develop the true precepts of a foundational space power theory, and the United States commits to advancing space power through that theory, space power in 2037 will indeed be awesome to behold and our ability to defend this country and its interests in space and on Earth will be assured.

American space power in 2007 may be impressive but it is also disjointed, chaotic, and not well understood. It is possible this will remain so thirty years hence. But if a foundational space power theory is developed and adopted, space power will truly become a "wonderful and mysterious power" whose "complex organism" will be a massive engine for human progress and prosperity, as well as a great shield and sword for free nations. American space power has a great history in the past, but it shows signs of stumbling in the present. The best way to ensure that it will have a yet more wonderful history in the future is to study and master foundational space power theory today.

Notes:

[1] Brig Gen William Mitchell, *Winged Defense*, reprinted in *Roots of Strategy Book 4,* David Jablonsky, ed. (PA: Stackpole Books; Mechanicsburg, 1999), 476.

[2] Stephen Metschan, "An Alternate Approach towards Achieving the New Vision for Space Exploration," AIAA-2006-7517; American Institute of Aeronautics and Astronautics, 2006, 12

[3] Ibid., 1.

[4] See Everett C. Dolman, *Astropolitik*; John J. Klein, *Space Warfare: Strategy, Principles, and Policy*; and Daniel O. Graham, *High Frontier: A New National Strategy* for three brilliant, and wholly ignored, examples.

[5] Lt Col Ed "Mel" Tomme, *USAF: The Paradigm Shift to Effects Based Space: Near-Space as a Combat Space Effects Enabler* (Maxwell AFB, Alabama: Airpower Research Institute, 2005), 1-2.

[6] Ibid., 2.

[7] Lt Col Charles M. Westenhoff, *Military Air Power: The CADRE Digest of Air Power Opinions and Thoughts* (Maxwell AFB, Alabama: Airpower Research Institute, 1990), 85.

[8] Mitchell, *Winged Defense*, 425.

[9] Mitchell, *Winged Defense*, 428.

[10] Mitchell, *Winged Defense*, 426-7.

[11] RADM Alfred T. Mahan, *The Influence of Sea Power Upon History:1660-1783* (New York: Dover, 1987), 23.

[12] Mahan, *The Influence of Sea,* 26.

[13] RADM Alfred T. Mahan, before the Senate Commission on the Merchant Marine, Washington, DC, statement, 25 November 1904; Robert Seager and Doris Maguire, eds., *Letters and Papers of Alfred Thayer Mahan Volume III: 1902-1914* (Annapolis, Maryland: Naval Institute Press, 1975) 620.

[14] RADM Stephen B. Luce, "Letter to Honorable J.H. Gallinger, chairman of the Mercantile Marine Commission, November 17, 1904," in RADM Albert Gleaves, ed., *Life and Letters of Stephen B. Luce, Rear Admiral USN* (New York: G.P. Putnam's Sons, 1925), 258.

[15] RADM Alfred T. Mahan, *The Influence of Sea Power Upon the French Revolution and Empire, Volume II* (Cambridge, Massachusetts: University Press, Elibron Classics repr., 2003), 372-3.

1st Lt Brent D. Ziarnick (BS, Space Operations, USAFA; MEng, Engineering Management–Space Systems, University of Colorado) is a wing tactics officer in the 50th Space Wing Weapons and Tactics Flight, Schriever AFB, Colorado. His duties include assessing and documenting the 50 SW's ability to deliver combat effects, leading the development and employment of tactics and countermeasures for defeating threats against 50 SW assets, developing tactical operations considerations and courses of action for wing senior leadership action, and advising senior staff on matters related to tactical employment of assets and mission planning considerations.

Lieutenant Ziarnick entered the Air Force upon graduating with academic distinction from the USAFA Class of 2003. He has been an operator, engineer, and tactician for the global positioning system (GPS) constellation in the 2nd Space Operations Squadron and 50th Operations Support Squadron.

Lieutenant Ziarnick is a 2005 graduate of the National Security Space Institute's Navigation Operations Advanced Course. He has previously published works on space strategy, space education, and joint space operations in military journals such as the *Army Space Journal*, and *High Frontier*. Lt Ziarnick is a first place winner of the Ira C. Eaker Award for writing the top *Air & Space Power Journal* article published during the 2005-2006 academic year.

General Schriever Essay Contest Winner

2nd Prize WINNER

Achilles' Heel: Space and Information Power in the 21st Century

Lt Col Scott R. Maethner
Chief of Strategy, Doctrine, and Policy
HQ AFSPC, Peterson AFB, Colorado

Overpowered in all his power, sprawled in the dust, Achilles lay there, fallen … ~ Homer, *the Iliad*

Since the end of the Cold War, the US military has enjoyed a formidable information advantage that has left it essentially unchallenged on the battlefield. Just as the great and powerful Achilles was instrumental to the Greek army in the Trojan War, space and information power enables American military success today—giving US forces a superior ability to *hear*, *know*, *talk*, and *see*. Space power has not only changed the American way of war, it has changed the American way of life as an increasing number of civil and commercial users depend on products and services derived from space systems probably more than they realize.[1] Precision navigation, global information services, attack warning, weather reports, entertainment, and a host of other satellite-enhanced products have revolutionized the way people work, live, and fight. However, dependence can breed vulnerability. Does space power have an Achilles' Heel that could render millions of space users *deaf, dumb, and blind*? This article demonstrates that an Achilles' Heel for space power does exist, and argues that the US should develop a strategy to protect this vulnerability. After briefly describing the historical and contemporary importance of space and information power, this article proposes that the space segment, with its present vulnerability to nuclear and kinetic attacks, represents the Achilles' Heel of space power. By acting now, America can provide an enforcement mechanism for the current outer space legal regime that will preserve and protect the space sanctuary by regulating access to space during times of peace, crisis, and war.

Achilles—21st Century Space and Information Systems

Over the past half century, space power played a vital role in enhancing US national security. In the early 1960s satellite reconnaissance and missile warning systems provided the US with strategic leverage to help pry back the Iron Curtain. These space systems gave the US global access, presence, and verification during the Cold War—a time when information about closed communist systems was at a premium.[2] Manned space programs enhanced national prestige in an ideological battle for the hearts and minds of underdeveloped nations. After the Cold War, space systems transformed beyond their strategic missions and began to focus increasingly on providing localized threat warning, communication, navigation, and intelligence in support of theater-level operational requirements across the spectrum of conflict.[3] Former Secretary of the Air Force Dr. James Roche likened present-day military space capabilities to oxygen: "If you have it, you take it for granted. If you don't have it, it's the only thing you want."[4]

The "second space age" ushered in an era of commercial competition in space.[5] Today, space products and services, once reserved for use by top-level government officials enable average citizens to exploit the advantages presented by the information age. Commercial satellites and users have surpassed military satellites and users in number, and projections suggest that in the near future, the vast majority of satellites will be dedicated to civil use.[6] Undeniably, space systems are providing a global utility, yet they remain relatively unprotected. Prominent leaders and scholars have called US space systems military and economic centers of gravity.[7] As these systems increasingly enable a nation of mobile information consumers, we are only beginning to appreciate the full impact space has on our daily lives. For example, incidents involving satellite malfunctions and operator errors have exposed an underappreciated dependence on space systems.[8] How would the American people react if US space systems were no longer available?

Achilles' Heel—The Space Segment

The *space segment* is the most lucrative target within the space system, because it is presently the most vulnerable segment and offers an adversary the most effective way to eliminate the advantage provided by space power.[9] Space power essentially plugs into a single outlet that resides in space. The Commission to Assess United States Space Management and Organization (The Space Commission) affirmed that space systems are "attractive targets for state and non-state actors hostile to the United States and its interests."[10] A would-be attacker could, of course, target each segment in an effort to disrupt, deny, degrade or destroy satellite services. However, control and ground segments of a particular space system, while easier to attack, are often quite robust by way of redundancy, mobility, dispersal, signal variance, and encryption techniques. A more effective approach for the adversary would be to simply pull the plug on space power by attacking the space segment directly. Although the space segment is not the easiest or the cheapest segment to strike, such a strategy would be the most effective because satellite designs have traditionally anticipated operation in non-hostile environments. Furthermore, an attack in space not only has the potential to damage fragile satellites, it also has the potential to affect the space environment. Fragments from over 124 satellite breakups account for the vast majority of the 10,000-plus objects tracked in orbit today.[11] This man-made hazard already affects missions by way of documented collisions and the need to reposition manned spacecraft during predicted close approach periods. This hazard likely will continue to affect the use of space in the future. For these reasons, the space segment is the most vulnerable, and therefore the most important, segment to protect; it is the Achilles' Heel of space power.

Paris' Arrow—Ballistic Missiles and Launch Vehicles

There is presently only one path to space, and that is on top of a rocket. Although there is a growing global dependence, no single country depends more on space than the US. Anyone who would want to level the playing field could do so rather quickly by attacking the space segment. Who would want to do such a terrible thing, and is it likely to occur? A number of congressional commissions suggest post-Cold War threats are real. For example, the Hart-Rudman Commission concluded, "America will become increasingly vulnerable to hostile attack on our homeland, and our military superiority will not entirely protect us."[12] Additionally, the Space Commission discussed the possibility of a "Space Pearl Harbor" attack on US space systems.[13] Both of these forecasts came before the devastating attacks of 11 September 2001 and the 11 January 2007 Chinese anti-satellite (ASAT) test. These are precarious times and the US needs to protect against further attempts by adversaries and extremists to take the world back to a time before ATMs, Direct TV®, XM® satellite radio, and just-in-time delivery.

How could such a Space Pearl Harbor take place? There are several possibilities. The first is a nuclear detonation in space. In 2004, the Commission to Assess the Threat to the United States from Electromagnetic Pulse outlined the serious and little-advertised danger to national security that would result from a nuclear explosion in space.[14] "A single nuclear weapon carried by a ballistic missile and detonated a few hundred miles over the United States would cause 'catastrophe for the nation' by damaging electricity-based networks and infrastructure, including computers and telecommunications."[15] The effects of such an incident would be wide ranging for information systems in space and air, as well as on land and sea. As an example of the threat to space, "just one such detonation holds the potential to disable all non-hardened low-Earth orbit (LEO) satellites."[16] X-rays produced from a nuclear detonation in space would immediately degrade or destroy the electronics of those unhardened space systems within the line of sight of the blast. The blast would also greatly increase natural radiation belts, thereby causing further degradation to satellite components.[17]

A second possibility for a Space Pearl Harbor is a kinetic attack by way of an ASAT weapon. This kind of attack could take the form of a co-orbital ASAT such as the Soviet Union developed and tested between 1968 and 1971, a direct ascent ASAT, or through explosive devices in Space.[18] Regardless of the method used, the introduction of perpetual space shrapnel would significantly increase the probability of impact between satellites and fragments in LEO. Objects in LEO have average relative velocities of 22,000 miles per hour, making an impact of even a very small fragment with a satellite lethal. Orbiting shrapnel from explosive devices in space would take the form of "debris clouds" that spread about the orbital plane of the source object and would contain "pinch points" or "pinch lines," thereby creating treacherous terrain of concentrated fragment densities.[19] The introduction of enough debris could eventually lead to cascading effects, whereby collision-induced breakups are a source of new orbital debris.

A third aspect, although not the result of malicious adversarial action, relates to the potential of the irresponsible use of space. A booming commercial satellite industry along with nations new to the satellite business could introduce hazards to established programs. The learning curve on the path to space faring nation status is rather steep. These newcomers—the celestial equivalent of student drivers—will likely make mistakes, causing seasoned space motorists to get nervous. Future space highways will become more crowded both physically and electromagnetically. Clearly, there is a need to establish rules of the road for space, but rules are meaningless if there is no way to enforce them.

Achilles' Armor – Preserving and Protecting Space

Is it possible to mitigate or eliminate Achilles' weakness? How do we protect space global utilities from the Space Pearl Harbor scenario or, for that matter, the irresponsible use of space? How do we ensure the benefits from space continue for humankind—today and into the future? The present debate on space weapons places idealists (who advocate a space sanctuary) and space hegemonists (who advocate space weapons) at the extreme ends of a continuum.[20] Ironically, however, the best way to preserve and protect the sanctuary of space may be to introduce a particular class of space weapons. Conventional space-to-ground weapons, combined with policies of passive defense and transparency, establish the essence of the *Achilles' Armor* strategy. This strategy involves modifying existing norms in the outer space legal regime to include the notion of space security by way of a tangible enforcement mechanism that would actively deny any unauthorized access to space.

In his argument for a space sanctuary strategy, Bruce DeBlois presented "… three viable approaches for defending US space assets: (1) diplomatic/political defenses (agreements aimed at building collective security), (2) passive defenses (hide-and-seek), and (3) active defenses (weapons)."[21] Mr. DeBlois went on to advocate a sanctuary strategy that follows "a combination of the first two and active, aggressive avoidance of the third."[22] The Achilles' Armor strategy, presented herein, accepts all three of Mr. DeBlois' approaches but on a broader scale and with a primary emphasis on a particular class of active defenses. Space operations are an inherently global activity. Therefore, preserving and protecting the space sanctuary will require a global solution. Protecting US assets alone, as Mr. DeBlois suggests, is a narrow strategy. In addition, Mr. DeBlois' emphasis on the first two options could indeed *mitigate* the Achilles' weakness, but a policy that adds and emphasizes the third approach of active defenses has the real potential to *eliminate* Achilles' weakness.

The centerpiece of Achilles' Armor is an active ballistic missile defense system. In 1983, President Ronald W. Reagan presented a bold vision for a defensive system that would shield the US against nuclear ballistic missile attacks and offered to share such a system with the world.[23] Present threats to the vulnerable space segment would dissolve with the introduction of a space-based missile defense. Dr. Everett Dolman resurrected the idea of space-based ballistic missile defense as part of an "Astropolitik strategy" whereby the US would "seize military control of LEO."[24] Dr. Dolman made a convincing case for the many technical, economic, and political benefits of the boost-phase intercept of a missile from a space-based weapon.[25]

There are additional advantages for Dr. Dolman's system when one applies it to the problem of preserving and protecting the space sanctuary. First, such a system would safeguard the space environment. Manmade environmental damage that would result from radiation-producing nuclear explosions or debris-producing kinetic events could not occur if the destructive payloads did not reach orbit. Second, the system would protect space from the introduction of space weapons. Many argue the adverse effects of an arms race in space. Placing a decisive space-to-ground weapon in LEO would prevent such a race from taking shape. To use Dr. Dolman's analogy, such a system would be the extraterrestrial equivalent of a naval blockade, preventing all unauthorized attempts to access space.[26] Only internationally accepted payloads that met predetermined design and operational standards could enter LEO. Hedging strategies attempt to preserve the sanctuary by pushing the issue of space weapons down the road, but the Achilles' Armor strategy would provide a tangible method to enforce the sanctuary.

Passive defenses can augment the active defenses described above and represent the second pillar of the Achilles' Armor strategy. Although active defense can prevent direct attacks, passive defenses can mitigate other kinds of attacks on the space segment. For example, designing smaller, disposable satellites would make finding, fixing, tracking, and targeting more difficult for ground-based lasers or directed-energy sources. Smaller satellites would permit more weight for shielding and/or more satellites per launch thereby increasing survivability and redundancy to the space segment. Control and ground segments could also easily adopt passive measures.

Finally, the third element of the Achilles' Armor strategy consists of the political and diplomatic efforts to sell the program both domestically and internationally. Ultimately, preserving and protecting the space sanctuary is more than an operational or technical problem. Because of the sensitivities involved with space and weapons, Achilles' Armor will require a "measured and discrete" approach.[27] Dr. Dolman's aggressive terminology and realist outlook that "the strong do what they can and the weak suffer what they must" is frankly too provocative to be productive.

Implementing the Achilles' Armor strategy will require the US to employ both power and prestige. Prestige involves the ability to persuade others to follow. Dr. Robert Gilpin describes power and prestige as the two most important components of control in the international system.[28] Prestige, he says, "is the functional equivalent of authority in domestic politics … [together] both power and prestige function to ensure that the lesser states in the system will obey the commands of the dominant state or states."[29] The viability of a controversial concept such as a space-based ballistic missile defense will require significant efforts to build and maintain US prestige in addition to US power. This is especially important considering the present resistance in the international community to follow the American lead in the Global War on Terrorism, and the perceived loss of US credibility associated with recent intelligence failures. Dr. Joseph S. Nye, Jr. claims that in a world of free access to large amounts of information, the credibility of the source as well as the content of the message is essential to getting others to follow one's lead.[30] Dr. Dolman's notion of America as the benevolent hegemon is less practical if the rest of the world questions American credibility.

Creating multilateral support for weapons in space is not impossible and will require a message others are willing to follow.[31] Dr. Martha Finnemore points out in her discussion on intervention that "multilateralism legitimizes action by signaling broad support for the actor's goals."[32] She also states, "norms that fit logically with other powerful norms are more likely to become persuasive and shape behavior."[33] One should be able to apply this logic to the problem of preserving and protecting the space sanctuary. Dolman illustrates that the international nature of the legal regime for outer space "has ostensibly been created on the overarching *principle* that space is the common heritage of all mankind, and on the *norms* that no nation should dominate there nor should large-scale military weaponry and activities take place there."[34] Is it possible for the US to build on the existing outer space legal regime by developing support for an enforcement mechanism? Sharing a space-based ballistic missile defense system as a public good with the world would be the first step toward evolving existing norms towards preserving and protecting the medium. Such a strategic move could pay dividends for the US. After all, "true strategic power is the capacity to manipulate shared understanding of rules, norms, and other boundaries that set the parameters of action."[35]

Implementing such a bold program will require unprecedented transparency in US space programs. Toward this end, the US should continue the trend of openness and competition created by recent US space policies and presidential decisions.[36] International inspections and registration of launch vehicles and payloads prior to launch will be an essential ingredient for determining whether particular missions meet established "space-worthiness" criteria.[37] As an additional gesture of good will, the US should share significant portions of its Earth imaging assets. Sharing these products and services, as well as US space infrastructure, and lessons learned will increase global dependence on space. This will add to the global expectation that one must preserve and protect space assets. Such a change will require the US to modify how it does business but should enhance international relations. In a world of abundant information, power and prestige result from information distribution. In fact "the more available accurate information is, the less incentive for dishonest behavior."[38] In another gesture of good will, an effective space-based ballistic missile defense would allow the US to significantly reduce its nuclear arsenal. These concessions of openness and arms reduction would help the US build both its prestige and power.

Conclusion

According to the current US National Security Strategy, "The gravest danger our nation faces lies at the crossroads of radicalism and technology."[39] America must not let Achilles fall. A nuclear or kinetic attack on US space assets would devastate this country's military and economic advantages. A space-based ballistic missile defense system will preserve and protect the space sanctuary by providing a tangible enforcement mechanism for the current space regime and would regulate access to space during times of peace, crisis, and war. America's military and economic well-being is too important to leave to a strategy of hope. "History will judge harshly those who saw this coming danger but failed to act. In the new world we have entered, the only path to peace and security is the path of action."[40]

Notes:

[1] Joint military doctrine defines space power as the "the total strength of a nation's capabilities to conduct and influence activities to, in, through, and from space to achieve its objectives." See Joint Publication (JP) 1-02, Department of Defense Dictionary of Military and Associated Terms, amended through 13 June 2007, http://www.dtic.mil/doctrine/jel/new_pubs/jp1_02.pdf.

[2] Michael V. Smith, "Some Propositions on Spacepower," *JFQ: Joint Force Quarterly*, 57.

[3] Benjamin S. Lambeth, *The Transformation of American Air Power, Cornell Studies in Security Affairs* (Ithaca, New York: Cornell University Press, 2000).

[4] Hon. James G. Roche, Air Force Association National Symposium Luncheon, 19 November 2004, http://www.afa.org/media/scripts/Roche_natlsymp04.asp.

[5] William E. Burrows, *This New Ocean: The Story of the First Space Age*, 1st ed. (New York: Random House, 1998), 625.

[6] Bruce Carlson, "Protecting Global Utilities," *Aerospace Power Journal* 14, no. 2: 39.

[7] Peter L. Hays, *United States Military Space: Into the Twenty-First Century* (Maxwell AFB: Air University Press, 2002), 11.

[8] Two incidents in particular show how the importance of space systems in our daily lives is often under appreciated until a satellite malfunction occurs. In 1998, a Galaxy IV satellite malfunction caused wide spread loss of service for pager, banking, news, and television customers. See Carlson, "Protecting Global Utilities," 37. In another example, an improper entry by a satellite operator into one of the global positioning system (GPS) satellites caused over 12 percent of the cellular network on the East coast of the US to shut down for an extended period. See Hays, *United States Military Space,* 110.

[9] Space power emanates from more than just satellites and spacecraft. In fact, a particular space capability relies on several segments of a greater space system. For example, a typical satellite system consists of a space segment (the satellites), control segment (link signals including telemetry, tracking and communication), and a ground segment (users terminals and relay stations).

[10] "Report of the Commission to Assess United States National Security Space Management and Organization," Washington, DC, 11 January 2001.

[11] The Aerospace Corporation Center for Orbital and Reentry Debris Studies, "Space Debris Basics: What is Orbital Debris?," 2005, http://www.aero.org/capabilities/cords/debris-basics.html (accessed 9 December 2005).

[12] Dr. John S. Foster, Jr. and Mr. Earl Gjelde, et al., "Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (Emp) Attack," volume I, executive report, 2004, http://www.globalsecurity.org/wmd/library/congress/2004_r/04-07-22emp.pdf.

[13] "Report of the Commission to Assess United States National Security Space Management and Organization" (2001).

[14] "Report of the Commission to Assess the Threat" (2004).

[15] Gertz Bill, "US Seen Vulnerable to Space 'Pulse' Attack," *The Washington Times*, 22 November 2005.

[16] Hays, *United States Military Space,* 101.

[17] Ibid.

[18] Ibid., 85.

[19] Aerospace, "Space Debris Basics," (2005).

[20] Karl P. Mueller, "Totem and Taboo: Depolarizing the Space Weaponization Debate," *Astropolitics* 1, no. 1 (2003): 9.

[21] Bruce M. DeBlois, "Space Sanctuary," *Airpower Journal* 12, no. 4: 48.

[22] Ibid.

[23] Burrows, *This New Ocean* (1998), 535.

[24] Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age, Cass Series—Strategy and History* (London; Portland, OR: Frank Cass, 2002), 157.

[25] For example, a weapon positioned in the high-ground of space has tremendous maneuver and energy advantages over a slower moving ascending missile. Additionally, any wreckage from a missile intercept in boost phase would fall back on the homeland of the attacker. Third, an ascending missile with multiple warheads or payloads would not have the chance to deploy them. Finally, space-based antiballistic missile defense would not require the ubiquitous forward presence in equipment and personnel that a ground, sea or air-based boost phase defense system would require. See Ibid., 164-65.

[26] Everett C. Dolman, "Space Power and Us Hegemony: Maintaining a Liberal World Order in the 21st Century," School of Advanced Airpower Studies,7, www.gwu.edu/%7Espi/spaceforum/Dolmanpaper%5B1%5D.pdf.

[27] Benjamin S. Lambeth, *Mastering the Ultimate High Ground: Next Steps in the Military Uses of Space* (RAND, Project Air Force: Santa Monica, CA, 2003), 122.

[28] Robert Gilpin, *War and Change in World Politics* (Cambridge, New York: Cambridge University Press, 1981), 30.

[29] Ibid.

[30] Joseph S. Nye, *The Paradox of American Power: Why the World's Only Superpower Can't Go It Alone* (Oxford; New York: Oxford University Press, 2002), 67.

[31] This highlights the importance of the messenger. Currently, the mouthpiece for protecting and controlling space is the US Air Force. The same military, that in the eyes of many around the world, imposes America's will by force. Selling the Achilles' Armor program domestically and internationally will require significant diplomatic skills. Consolidating the four space sectors under one cabinet level position will not only reduce duplication of effort but will put a diplomatic face on what is largely a global and political problem.

[32] Martha Finnemore, *The Purpose of Intervention: Changing Beliefs About the Use of Force, Cornell Studies in Security Affairs* (Ithaca: Cornell University Press, 2003), 82.

[33] Ibid., 72.

[34] Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, 88.

[35] Everett C. Dolman, *Pure Strategy: Power and Policy in the Space and Information Age*, 1st ed., Cass Series—Strategy and History; 6 (London; New York: Frank Cass, 2005), 90.

[36] For example, Presidential Decision Directive 23 of March 1994 created incentives for a commercial remote sensing industry. See Hays, "United States Military Space: Into the Twenty-First Century," 104; Also, the Commercial Space Act of 1998 created conditions for privatizing space launch functions. *Air University Space Primer* (2003 [cited 11 December 2005]), http://space.au.af.mil/primer/; Finally, the US Government turned off the global positioning system's (GPS) selective availability on 1 May 2000, thereby improving the accuracy of every GPS receiver. See "United States Lifts Gps Restrictions," Civil Engineering (08857024) 70, no. 7.

[37] Hays, *United States Military Space*, 103.

[38] Dolman, *Pure Strategy*, 87.

[39] George W. Bush, National Security Strategy of the United States of America, The White House, 2002, http://www.whitehouse.gov/nsc/nss.pdf.

[40] Ibid.

Lt Col Scott R. Maethner (BA, Physics and Mathematics, Concordia College, MN; MS, Space Operations, Air Force Institute of Technology; MMOAS, Air Command and Staff College; MAAS, School of Advanced Air and Space Studies) is the chief of Strategy, Doctrine, and Policy, HQ AFSPC, Peterson AFB, Colorado. He is responsible for providing strategic guidance for AFSPC's long-range planning process, developing, and coordinating Joint and Service doctrine, and preparing joint warfighting concepts and space policy.

Colonel Maethner entered the Air Force in 1990 as a distinguished graduate of the ROTC program at North Dakota State University. His career includes assignments as a scientist and program manager at the Air Force Phillips Laboratory, flight commander positions at the 4th Space Operations Squadron (Milstar) and the 400th Missile Squadron (Peacekeeper), and a staff assignment at the 14th Air Force.

Colonel Maethner's awards include the Meritorious Service Medal with two oak leaf clusters, the Air Force Commendation Medal and the Air Force Achievement Medal with two oak leaf clusters.

General Schriever Essay Contest Winner

3rd Prize WINNER

The Age of Asymmetric Space Warfare

1st Lt Justin M. Smith
Milstar Payload Engineer, 4th Space Operations Squadron, Schriever AFB, Colorado

On 19 February 1957, at the inauguration of the Air Force Office of Scientific Research Astronautics Symposium in San Diego, General Bernard A. Schriever emphasized America's dire need for space superiority.[1] On that day, this space pioneer shared his vision of space as an opportunity, one we now call the ultimate high ground. Opportunity, however, is an indiscriminate concept. Eight months later the Soviet Union launched Sputnik, the world's first artificial satellite.[2] General Schriever sensed the coming race to master the new battlefield of space—and the United States had already been beaten out of the starting gates.

50 years later, the status of US space supremacy is in stark contrast to its beginning. With many active satellites in various orbits, the US military operates more space platforms than any other country's combined sum of civil/military satellites. With missions ranging from weather and communications to imaging and missile defense, there is no rational case to be made against the US having achieved the goal of space superiority set by General Schriever. Although it is a revered position atop the champion's pedestal, it also warrants meticulous examination from potential competition.

This notion came to stark relief on 11 January 2007, when China successfully tested an anti-satellite (ASAT) weapon on one of its own satellites.[3] Suddenly, space assets which had operated without credible threats for years suddenly had become potential targets. This test did more than demonstrate the ability of a foreign power to destroy on-orbit systems; it may have very well ended the golden age of undisputed space supremacy that America has enjoyed since the Cold War, demanding change to current doctrine and revealing a critical vulnerability in the realm of asymmetric space warfare.

Sun Tzu's quote (below) reveals a very simple, yet important lesson. The US has developed a certain sense of inevitable complacency over its unchallenged superiority to date in space. The comfort with our current posture is a product of many influences, but one is particularly significant. Consider our only credible enemy in the history of space warfare, the former Soviet Union. Early on, the USSR sought to win the space race, intending to attain the ultimate high ground and use it as a force multiplier to accomplish its regional and global objectives. Both the US and USSR researched and tested ASAT capabilities to thwart the other, but soon abandoned the programs due to cost and an important strategic fact: if satellites are blown into numerous pieces, they then become a hazard for all other satellites in nearby orbits. The kinetic ASAT is a discriminate killer; the debris it creates is not. Thus in the Cold War, space was determined to be too valuable of an asset to be rendered useless to all parties by cluttering it with harmful satellite remnants. The US evolved and adapted to these unspoken rules of space warfare. America had won the last competition in space after a very rocky start and spent several unchallenged years building further dominance. How, then, could any new threat even begin to challenge?

Space adds significant value to our nation's defense by allowing seamless integration of the joint application of force projected *globally* on any adversary. This global reach defines not only a space capability, but a wartime philosophy. No other military has the capability to take a fight and deliver combat effects anywhere in the world as quickly and effectively as the US Space bolsters this capability by allowing the warfighter to master unfamiliar terrain, to coordinate attacks down to the second, to gather valuable intelligence, to put bombs within inches of a target, and much more. In a sense, it maximizes efficiency allowing a relatively small force to inflict an awesome amount of damage in a very short time.

Although highly valuable to military applications, space is also important for commercial use. The commercially driven global telecommunications industry alone earned an estimated $1.21 trillion in revenue in 2005. By 2010, US investment in space is expected to be $500 - $600 billion—approximately equal to all current US investments in Europe.[4] The global positioning system (GPS) provides all weather targeting capability, but also provides timing that allows automatic teller machines to work. Imaging satellites scout enemy positions, but also survey hurricane damage allowing relief efforts to be concentrated accordingly. Weather satellites project forecasts

"If your enemy is secure at all points, be prepared for him. If he is in superior strength, evade him. If your opponent is temperamental, seek to irritate him. Pretend to be weak, that he may grow arrogant. If he is taking his ease, give him no rest. If his forces are united, separate them. If sovereign and subject are in accord, put division between them. Attack him where he is unprepared, appear where you are not expected."
~ Sun Tzu, *The Art of War*

"In the long haul, our safety as a nation may depend upon our achieving 'space superiority.' Several decades from now, the important battles may not be sea battles or air battles, but space battles, and we should be spending a certain fraction of our national resources to ensure that we do not lag in obtaining space supremacy."

~ General Bernard A. Schriever

for both air strikes and weekend vacations. Television, communications, and global commerce in general—all depend on space. Whether analyzed from a commercial or military perspective, space is a cornerstone on which modern day living in this country depends.

With such an invaluable role for commercial and military application, why isn't everyone occupying the ultimate high ground? At present, space is an elite club with a cover fee that only few nations can afford. In a battlefield without borders, naturally limited access based on cost and technical complexity, then, is a defense of its own. With only a few nations with the financial and technical prowess to put a system on orbit, space is, at least for now, naturally fortified. Furthermore, once on station, destroying an enemy's satellite is potentially a death sentence for friendly satellites in nearby orbits. These two facts have been the general concept of defense in this arena for years, but no longer appear to hold true.

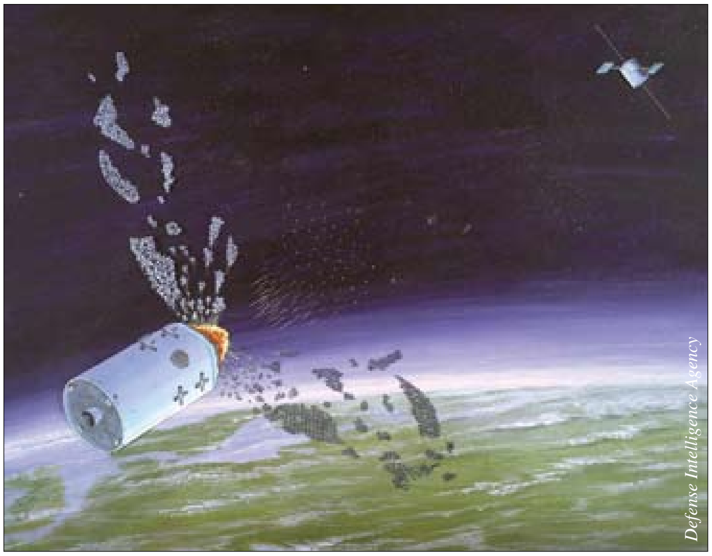
As previously mentioned, China successfully tested an ASAT in January. True to our space heritage, the first reaction from many was the possibility of another space race. This event, however, spurs a much deeper concern. Although space is a tremendous asset to our nation in both a military and commercial sense, it has also become a tremendous source of dependence. With China's demonstration of ASAT capability, the new question is one of motivation: how could any nation use a kinetic ASAT when the risk of damaging friendly systems is so high? The answer is simple: our competition today is not like the competition of the past.

In today's battlefield, we are witnessing a new type of warfare with suicide and roadside bombings. The enemy has discovered how valuable a single life is to the US, whether it is an American soldier or an innocent Iraqi civilian. Although valuing life is a moral foundation in our minds, it is an exposed vulnerability in theirs. In fact, our current adversaries are so adamant about exploiting this vulnerability, they do not hesitate to strap explosives to themselves and run into crowded areas. With every detonation, the body count grows and the public's support for the war declines. Case and point, this illustrates a textbook approach to finding a vulnerability and exploiting it. As radical as the method of exploitation is, its effectiveness is unquestionable.

Now, transition that mindset to space. With previous adversaries, the objective was to win the space race and solidify control of the ultimate high ground. Today, this is not necessarily the case. In the past, no one really had a strong enough foothold to exploit space as universally as the US does today. With space still in contention, there was still hope for an adversary to win the race. Eventually, this hope dwindled as the US and its allies cemented their presence on orbit. So what does the modern adversary do when confronted with a hopeless battle on conventional terms? They employ radical ideas and tactics to pull the fight to asymmetric conditions.

Just as these tactics are put to deadly use in Iraq, they can be put to use in space with even greater impact. Imagine numerous ASATs lifting off every day out of the Middle East, progressively striking satellites in numerous orbits. Whether a friendly or hostile target, the debris these strikes create impacts other satellites in nearby orbits, perpetuating the destruction. Even if another satellite were on the pad ready to launch, sending it to such an orbit would assuredly mean joining the numerous rings of orbiting space junk. Suddenly, the ability for the US to wage war on foreign soil would be severely mired. No longer could we use space as the ultimate high ground, for it would have turned into the ultimate graveyard. The effects on the US economy would be catastrophic as well, considering the implications of a trillion dollar industry crashing in only a few months. To continue the earlier analogy, if space were an elite club with limited access, today's adversaries would rather bomb it than

US Vought ASM-135 ASAT missile launch on 13 September 1985.



Soviet Anti-Satellite System, artists rendering by Ronald C. Wittmann, 1986.

try to gain admission. With so much US dependence on space based systems, what would the world be like if one day it were suddenly denied as a feasible area of operations?

As irrational of an idea as this is, space doctrine must start to account for the possibility of "kamikaze" tactics. When put into perspective, the only real defense for space today is philosophical; if everyone uses it for peaceful purposes, everyone reaps the benefits; therefore, no one is irrational enough to clutter orbit with indiscriminate ASAT debris. But when an adversary suddenly gets the idea that they don't want to *use* space, but simply *deny* it to everyone as an asset, the landscape of modern warfare changes dramatically. This shift in doctrine to cover asymmetric space warfare could come in many forms, and as space professionals of the future, it is imperative for us to consider what tomorrow may bring. What to do about this threat, however, is a question in dire need of debate and action within our community.

Will a laser based system that disables satellites be the future? Or will it be old-fashioned debris clouds created by kinetic ASATs that shape tomorrow's battlefield? In either case, space is no longer an arena of the elite and can be influenced by any nation willing to buy proven ASAT technology. China has already proven it to be affordable and functional. Furthermore, adversaries of the present are in stark contrast to those of the past, openly willing to pursue radical tactics without regard for collateral damage. The notion of mutual peaceful operations on orbit is very rapidly becoming void. With all of the complicated technological advancements of tomorrow, a single kinetic ASAT and its impact cannot be ignored. Defense against new and radical on-orbit tactics requires immediate integration into current doctrine to maintain US space supremacy of the present and future. Space professionals of today must continue to apply General Schriever's vision to tomorrow, but must also adapt to the coming age of asymmetric space warfare.

"If you entrench yourself behind strong fortifications, you compel the enemy to seek a solution elsewhere." ~ Karl von Clausewitz

Notes:

[1] Air Force Link, "Gen Schriever's Visionary Space Speech Turns 50," 21 February 2007, special staff report, 50th Space Wing Public Affairs, http://www.af.mil/news/story.asp?id=123040817 (accessed 1 July 2007).

[2] NASA, "Sputnik and The Dawn of the Space Age," 12 April 2007, http://history.nasa.gov/sputnik/.

[3] Stephanie C. Lieggi, "Space Arms Race: China's ASAT Test a Wake-up Call," Center for Nonproliferation Studies, 24 January 2007, http://cns.miis.edu/pubs/week/070124.htm.

[4] Michael Krepon, "Lost in Space: The Misguided Drive Toward Anti-satellite Weapons," *Foreign Policy* 80, no. 3 (May/June 2001): 2-8, http://www.spacedebate.org/evidence/1515/.

1st Lt Justin M. Smith (BS, Astronautical Engineering, USAFA) is a Milstar payload engineer, 4th Space Operations Squadron, Schriever AFB, Colorado. He is responsible for supporting the communications payload and various control actions of the Milstar constellation to include planning and executing operations activities and anomaly resolution. As senior payload instructor, he is responsible for training new engineers and supplementing the knowledge of space operators for the 50th OG.

After graduating in 2005, Lieutenant Smith began as the assistant director of operations for the 2005 Nellis Air Show with the 57th OSS, Nellis AFB, Nevada, before being sent to UPT at Moody AFB, Georgia. Lieutenant Smith has several awards including the Air Force Achievement Medal and German Armed Forces Efficiency Badge.

General Bernard A. Schriever Memorial Essay Contest

The Air Force continues to rely on our Airmen and civilians to be visionaries and critical thinkers. This contest brought out some of the best in our space professionals and provided a rewarding vehicle to articulate their innovative ideas.

The Lance P. Sijan Chapter of the Air Force Association sponsored the contest and the prizes. Without their support, the event would not have been possible.

For more information:

http://www.schriever.af.mil/library/essaycontest.asp

Book Review

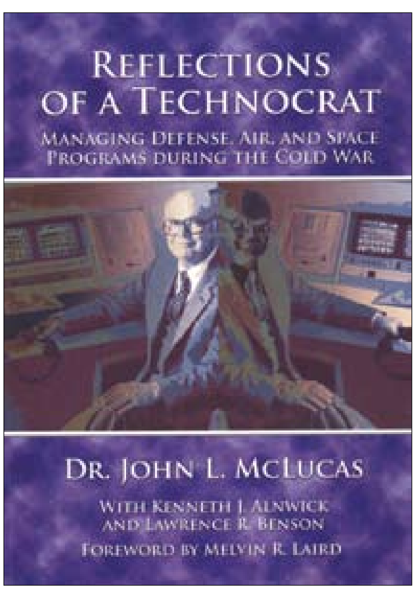
Reflections of a Technocrat: Managing Defense, Air, and Space Programs During the Cold War

By Dr. John L. McLucas with Kenneth J. Alnwick and Lawrence R. Benson. Maxwell AFB, Alabama: Air University Press, 2006. Notes. Photographs. Appendix. Abbreviations. Bibliography. Index. Pp 390. Free to Airmen. Available from http://www.au.af.mil/au/aul/aupress/catalog/books/McLucas_B-101.html

In recent decades, scholars have used the term Technocrat as a polite synonym for bureaucrat. However, in the case of Dr. John McLucas and his colleagues, the term is applied more narrowly to identify those at the higher echelons of government and business who combine managerial competence with scientific and technical knowledge, often credentialed with advanced academic degrees. This book details the life of John McLucas and his many accomplishments. Dr. McLucas spends a majority of the book chronicling his life, his dedication to public service and unending endeavor for the betterment of society through science and technology.

His education, intellectual interests, technical knowledge, and managerial skills allowed him to rise through the ranks to positions of responsibility in commercial as well as nonprofit companies, professional associations, and the federal government. Dr. McLucas lived by the credo, "Engineers need to have a greater understanding of the relationships between user and machine, between the individual and the technology." From his meager start on his father's farm in North Carolina, Dr. McLucas's background was quite different than that of his professional colleagues. Through a series of events following his father's death, his mother sent him to live with his aunt and uncle in the hopes of exposing him to a different lifestyle. These events set his life into motion on a path towards tremendous achievements.

After graduating college he received a graduate fellowship to earn his master's degree in physics and electrical engineering. It was during this time that he became interested in a nascent technological development called Radio Detection and Ranging (RADAR). Soon after, Dr. McLucas accepted a commission into the United States Navy as a RADAR officer. Following his naval service, Dr. McLucas began an extensive relationship with the Air Force as a civilian engineer as well as an Air National Guard officer. This affiliation continued as president of both a ground-breaking technological company and the Air Force-sponsored Massachusetts Institute of Technology Research and Engineering (MITRE) Corporation where he continued to develop and promote revolutionary technological advances in both air and space.



Following his tenure at MITRE, Dr. McLucas spent a great deal of time working at the Pentagon in the Office of the Secretary of Defense and had the honor of holding the title of the North Atlantic Treaty Organization's top scientific officer. His Air Force achievements culminated after reaching the highest civilian position in the USAF, serving as its secretary during the highly demanding and transformational period from 1969 through 1975. During this time he also directed the National Reconnaissance Office (NRO), which at the time was kept so tightly under wraps that even the acronym NRO was highly classified. Dr. McLucas's insider account of those years reveals numerous details about Pentagon politics, coping with the Vietnam War, the development of experimental space systems, and the progress of equal opportunities for women and minorities.

While working for the Department of Defense as the director of the Tactical Warfare Program, he helped develop programs such as High Altitude Radiation Detection which was capable of identifying exoatmospheric nuclear bursts and later worked on the development of the Minuteman III weapon system. Other seminal accomplishments include heading the Federal Aviation Administration (FAA) and becoming an executive in the Communications Satellite Corporation; Dr. McLucas is the only person to have held the positions of both secretary of the Air Force and administrator of the FAA. Upon retirement, he continued to be an active promoter of science and technology, particularly in the realm of space. His desire was to advance space technology in support of learning more about Earth, through the examination of the ozone layer, polar holes, population distribution and other occurrences of global change, in hopes of creating a space age enlightenment for future generations.

The value of this book to the space professional extends from its basic explanation of the bureaucracy encountered at the upper levels of the US government and the means it takes to put actual programs into motion. Although it does not delve into the inner workings of policy and procedure, getting to see the bigger picture sheds a new light on the process behind Air Force acquisitions in regards to research and development. In documenting his extensive career, Dr. McLucas offers new insights into the history of key government as well as civilian agencies during the Cold War era. For the space professional, it provides a glimpse of what occurred behind the scenes, such as various projects developed to monitor Russian space launches, missile defense systems and the myriad uses of satellite technology. Although it did not discuss any one particular area in-depth, it gives the reader a closer look at the man behind the air and space defense programs that took place during the Cold War.

Reviewed by 2nd Lt Daniel A. Jimenez, officer in charge, Convoy Response Force, 341st Security Forces Group, Malmstrom AFB, Montana.

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AFSPC/PA
150 Vandenberg St.
Ste 1105
Peterson AFB, CO 80914
Telephone: (719) 554-3731
Fax: (719) 554-6013
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