

The Aerospace Force

Defending America in the 21st Century



... a white paper on aerospace integration



“The United States Air Force is moving forward into the 21st Century as a seamless, integrated aerospace force.”

— General Michael E. Ryan



U.S. AIR FORCE

**Department of the Air Force
Washington, DC**

The Aerospace Force: Defending America in the 21st Century is a white paper and a key pillar to the new Air Force Vision. At the dawn of the new millennium, the Air Force is directing its strategic vision to meet the nation's requirements within a rapidly changing world. As a key pillar to the strategic vision, this document presents the Air Force view of the future of aerospace power. It pays tribute to those who led the Air Force into the air and then into space, and challenges the leaders of the next generation to take advantage of the synergies inherent in aerospace capabilities. It provides the conceptual foundation for the full spectrum aerospace force and establishes the context for the Aerospace Integration Plan that outlines the next steps the Air Force will take on its aerospace journey.

The message of *The Aerospace Force* applies to the entire Air Force community, but this document is primarily for those of you who will be a part of, and will lead, the Air Force in the 21st Century. To succeed as tomorrow's aerospace leaders, your charge is to continue molding our air and space capabilities into a seamless force. Your support in the integration of air and space systems will lead to advances in our warfighting capabilities, new concepts of operations, and new technologies throughout the aerospace continuum. Your legacy will be a full spectrum aerospace force that is organized, trained, and equipped to control and exploit the aerospace continuum. It is our mission and our future—take us there.



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EXECUTIVE SUMMARY

Our vision for the future is one of integration of our systems and our people. We will use the best systems that we have available for each task, without regard to whether that system works in the air or in space, and fuse them into an integrated whole using the information systems that we are building today. In addition, we need to ensure that each of our men and women have an opportunity to understand how air and space systems fit together to do our mission.

—F. Whitten Peters, Secretary of the Air Force, 2000

The United States has global interests that place a premium on the vigilance, reach, and power aerospace forces provide. Our forces will respond quickly anywhere, often in places where we have imperfect knowledge. As part of the joint team, our evolving aerospace force deters aggression, compels our adversaries, renders them incapable of action, contains conflict, conducts humanitarian operations, and fights our nation's wars. The best way to fulfill our warfighting responsibilities to the joint team and the nation is through the further integration of air and space capabilities.

The Air Force's objective in pursuing the harmonization of our people and systems is to master the application of aerospace power to support the nation's interests. This objective entails fielding a full spectrum aerospace force with the full range of capabilities to control and exploit the aerospace continuum.

Our Service views the flight domains of air and space as a seamless operational medium. The environmental differences between air and space do not separate the employment of aerospace power within them. Commanders of aerospace power will be trained to produce military effects for the Joint

Force Commander¹ (JFC) without concern for whether they are produced by air or space platforms. By focusing on operations, our efforts will not just enhance airpower, but will capitalize on the broader capabilities of aerospace power to field a more capable warfighting aerospace force, dominating the vertical dimension and achieving decisive results in conflict.

As the Air Force has evolved since 1947, it has made great strides in controlling and exploiting the air. Although the Air Force has accomplished much in the exploitation of space, a challenge for our 21st Century aerospace force will be to establish an appropriate level of control in space as we have done in the air.

This level of space control will be achieved by maintaining our situational awareness throughout the aerospace continuum, protecting our ability to use space, preventing adversaries from exploiting U.S. or allied space capabilities, and negating the ability of potential adversaries to exploit their own space capabilities.

For those now serving, most aerospace objectives will seek to shape the geopolitical environment and neutralize security threats on



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the Earth's surface. As more space-faring countries emerge and technology advances, however, potential threats from and in space will increase. The future Air Force role to counter these threats will follow the guidelines established by the current National Security Strategy.

We [The United States] are committed to maintaining our leadership in space. Unimpeded access to and use of space is essential for protecting U.S. national security.... Our policy is to promote the development of the full range of space-based capabilities in a manner that protects our vital security interests.²

We have come a long way in building the full spectrum aerospace force. The precise navigation and timing data made available to the world by the Global Positioning System (GPS) has revolutionized navigation for both military and civilian applications. In terms of systematically developing the next generation of aerospace officers, we have taken a first step with the implementation of the Aerospace Basic Course at Air University. These are but two examples of how the pursuit of aerospace integration greatly enhances our capabilities and personnel today and will continue to do so tomorrow.

The Air Force is not the only service or organization that operates in the flight domains of air and space, and we make no exclusive claim to the aerospace continuum. General Ronald Fogleman, former Air Force Chief of Staff, once remarked, "We are asked to provide...air and space forces. We have no other tasks."³ The Air Force is charged,⁴ however,

Operation Allied Force

Our recent performance in Kosovo demonstrated the potential and realization of aerospace integration on our warfighting operations. The synergies of combined air, space, and information competencies were displayed as the joint team eliminated strategic, operational, and tactical targets, day and night, in all-weather conditions.

A large part of our success in Operation Allied Force was based on the integration of personnel brought together in the Air Operations Center. This potent combination of air, space, and information warriors is a new standard to which all Aerospace Operations Centers will be held in the future.

with providing the full measure of efficient, effective, and interoperable aerospace capabilities to the JFC, our sister military Services, and other agencies.

The best way to accomplish this task is to increase our effectiveness and efficiency, and to create new capabilities through aerospace integration. Executing this approach will advance our Core Competencies—the Air Force's contributions to the joint team—and enable the Air Force to play a more effective role within the broader aerospace community that includes intelligence, civil, and commercial applications.

While most of this document describes military functions, we recognize that the Air Force contributes to national aerospace power—the application of air and space capabilities from the national security, civil, and commercial aerospace sectors to promote overall national interests. The United States is an

aerospace nation, and the Air Force is its aerospace force.

One example of national aerospace power is the close relationship between the Air Force and the Intelligence Community. Our strategic partnership with the National Reconnaissance Office (NRO) is based on operational cooperation for war-fighting and the large number of personnel the Air Force contributes to the NRO's mission. In the future, the Air Force-NRO partnership will continue to grow as the differences between tactical and strategic intelligence decrease.

Our vision for an aerospace force involves thoughtful changes to our personnel, organization, employment concepts, equipment, support for the joint team, and our role in the broader aerospace community. Providing the foundation for those changes will be the remarkable men and women of the Air Force. In order to make further progress toward our objective aerospace force, the Air Force is taking steps to change training, education, organization, and career development patterns to develop future aerospace leaders. These leaders of tomorrow will understand the capabilities and limitations of air and space platforms, as well as the synergies they bring to the battlespace. Then, they will demonstrate the new operational concepts aerospace power provides. In essence, our Service will train and develop officers, enlisted personnel, and civilian members to understand how aerospace power contributes to mission accomplishment and will provide

opportunities to gain the necessary experience. These people will lead the full spectrum aerospace force of the 21st Century.

Likewise, our vision includes a mix of air and space capabilities interacting for maximum effect throughout the aerospace continuum. This vision encompasses aerospace capabilities to find, fix, assess, track, target, and engage any object of military significance on or above the surface of the Earth in near real time. Our systems will be interoperable and thoroughly integrated. The result will be an aerospace force with more compelling capabilities, fewer vulnerabilities, and acceptable overall costs.

As a demonstration of our Service's commitment to realize the full spectrum aerospace force, we will accomplish the following initiatives over the next few years:

- Provide career-broadening opportunities for our people, developing an aerospace mindset throughout the entire Air Force;
- Expand aerospace education and training for all enlisted members to enhance their contribution to our aerospace force;
- Field Aerospace Operations Centers (AOCs) as weapon systems;
- Broaden Joint Force Aerospace Component Commander training to include specific aerospace education and field experience and offer this training to space, information, and battle management personnel;



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- Field a data fusion system to directly support AOC functions;
- Develop dynamic space simulations for exercises and wargames to train our people in the use and limitations of our aerospace capabilities; and
- Develop analytical tools to evaluate ground, air, information, and space systems as acquisition options.

Aerospace integration is a process, not simply an objective. Nevertheless, we will continue to move forward because we know the systematic combination of air and

space capabilities is the best path for the Air Force to fulfill its national security obligations.

The leadership of the United States Air Force is committed to further integrating its people and air and space capabilities into a full spectrum aerospace force. Success will depend on the personal commitment of every member of the Air Force family—active, reserve, and civilian—for the actions of these men and women will ensure that our Service meets its responsibilities to advance our national interests.

THE AEROSPACE FORCE

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1. INTRODUCTION

The United States Air Force is moving forward into the 21st Century as a seamless, integrated aerospace force. The Air Force is committed to continue the integration of air and space. We have made great strides in many areas but we need to go further. Integration is a journey, not a destination.

—General Michael E. Ryan, USAF Chief of Staff, 1999

Aerospace integration is the best way to advance our warfighting capabilities and continue to fulfill our roles within the joint team. The increased effectiveness and efficiency of our operations, and new capabilities enabled by joining air and space competencies, has prepared our Service for the challenges of the 21st Century.

The Aerospace Force: Defending America in the 21st Century explains the basis for aerospace integration, reviews our progress, commits our Service to further integration to enhance the capabilities of our future force, and describes that future force.

The Air Force has a rich heritage of adapting new thinking to change our Service as the nation requires. The Air Force was born from technological innovation, and it continues today to expand its capabilities and operational concepts.

The merger of air and space capabilities is an ongoing effort. In fact, this process may never be finished because integration is not an end state. New air, space, and aerospace platforms are entering the inventory, while others are in the development and planning stages. Our constant challenge will be to ensure our Service identity and cul-

ture evolve with our increasing aerospace capabilities.

Aerospace integration is driving changes in our personnel and their development, organizations, equipment, resourcing, and employment concepts. Fundamental to our success is personnel integration. The men and women of the Air Force—officers, enlisted personnel, and civilians—all play a role in this process. Their understanding of aerospace power and their creativity in finding new solutions to the nation's challenges will be the foundation for the full spectrum aerospace force. By drawing on the talent of every man and woman in the Service, the aerospace force will become a reality.

The Air Force is bringing air and space closer together. In the decade since Operation Desert Storm, we have developed new capabilities in navigation, precision strike, intelligence, and communications. We now fuse information in innovative ways, developing uses that did not exist even a few years ago. Similarly, we have combined air- and space-skilled personnel in our Aerospace Operations Centers. We displayed to the world the extent of our progress in Operation Allied Force. Technological advances and the concepts of operations that rely on that technology will play a lead-



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ing role in the continuing integration of air and space capabilities.

Together, the people, equipment, employment concepts, and organizations of the Air Force will merge into a full spectrum aerospace force.

The continued success of aerospace integration lies in the personal commitment of every man and woman in the Air Force. You will make the vision of an aerospace force a reality.

2. THE JOURNEY FROM “AIR AND SPACE” TO “AEROSPACE”

Whoever has the capability to control space will likewise possess the capability to exert control of the surface of the Earth. We airmen who fought to assure that the United States has the capability to control the air are determined that the United States must win the capability to control space.... There is no division...between air and space. Air and space are an indivisible field of operations.

—General Thomas D. White, USAF Chief of Staff, 1957

An aerospace force is based on the view that air and space form a single, seamless operational medium. Based in our doctrine and our culture, this view will allow us to further our warfighting capabilities.

The continuing merger of our formidable air and space capabilities and talented people will advance our evolution from the air and space force we have been toward the full spectrum aerospace force we are becoming. The result of this process will be a force that exemplifies the attributes and tenets of aerospace power.⁵

A Seamless Operational Medium

Whatever differences there are between air and space are not important. What is important is achieving the desired effect on the battlefield. Whether it is weapons, communications, or information, the warriors out there do not care where it comes from as long as it has the right impact.

—General John P. Jumper,
Commander, U.S. Air Forces in
Europe, 1999

Although our Service views the aerospace continuum as an operational medium, we of course recognize environmental differences between air and space. The Air Force Scientific Advisory Board recently referred to air and space as

Aerospace Definitions

Aerospace describes the seamless operational medium that encompasses the flight domains of air and space.

An **aerospace force** is comprised of both air and space systems, and the people who employ and support those systems, and has the full range of capabilities to control and exploit the aerospace continuum.

Aerospace integration is the set of actions harmonizing air and space competencies into a full spectrum aerospace force and advancing the warfighting capabilities of the joint force. These actions are parallel, sequential, and mutually coordinated. They occur simultaneously in the areas of organization, training, and equipment that lead to or reflect changes in warfighting concepts, doctrine, resourcing, and culture. Aerospace integration actions can also include actions that incorporate and exploit capabilities made available from non-military or non-Air Force communities.

Aerospace power is the use of lethal and nonlethal means by aerospace forces to achieve strategic, operational, and tactical objectives. Aerospace power can rapidly provide the national leadership a full range of military options for meeting national objectives and protecting national interests.

two flight regimes—one that ignores Kepler and the other that ignores Bernoulli.⁶ However, these differences do not separate the employment of aerospace power



within the flight domains of air and space. Commanders of aerospace power produce military effects for the JFC without concern for whether the effect is produced by an air or space platform.⁷ In short, this focus represents a means of leveraging aerospace power's advantages to create the desired effects at the right place at the right time.

Space capabilities have always been global capabilities. As more air capabilities reach from the United States to the battlespace and back, air is becoming more global as well. Just as satellites are not tied to one region or another, air assets such as long range bombers are global assets capable of performing their missions from launch bases in the United States.

The air ocean and its endless outer space extensions are one and indivisible, and should be controlled by a single homogeneous force.

—Major Alexander P. de Seversky

Similar to space platforms, air assets are limited resources in great demand because of their unique capabilities. The combination of necessary broad reach and scarcity of resources poses a dilemma for both the regional commander and the Air Force. The best solution, as we learned in World War II and repeatedly since then, is to apply aerospace power according to one of its key tenets—centralized control and decentralized execution.⁸

The integration of air and space capabilities during Operation Allied Force underscored our view of the

seamless operational medium. For the first time, we were able to calculate the precise coordinates required by our satellite-guided munitions for targets that were identified with a Predator unmanned aerial vehicle (UAV) video camera. This real-time targeting was realized with the data fusion capability of the Joint Targeting Workstation. In less than one minute, Predator video data was combined with three-dimensional terrain data derived from national satellites then linked via satellite and radio to the cockpits of aircraft that were flying over Kosovo and Serbia. This combat capability demonstrated the synergy of using manned and unmanned air and space capabilities together. Furthermore, the Eagle Vision system fused commercial space imagery with national data to produce detailed and flexible three-dimensional images of target areas for pre-mission aircrew rehearsals.

Clearly, impressive integrated capabilities are available today, but some potential has yet to be realized. Many of today's air and space systems were not designed to be compatible in a system-of-systems construct. Tomorrow's air, space, aerospace, and ground systems will be designed to operate together, without regard for the system's operating environment. Also, the products of these systems will be exploited through systematic data fusion and analysis to produce timely and accurate information, disseminated in forms applicable to every Air Force user.

Control and Exploitation of the Aerospace Continuum

As the Air Force has evolved since 1947, we have made great strides in controlling and exploiting the air. On the other hand, the first 40 years of the space age were devoted largely to the exploitation of space capabilities. The future will require a balance between exploitation and control as adversaries seek to deny the United States its space advantages.

We are not America’s only operator in air and space, and we make no exclusive claim to the vertical dimension. But we are responsible for providing the full measure of efficient, effective, and interoperable aerospace capabilities to the joint team. In fact, the Air Force fields the majority of both air⁹ (fixed wing) and space¹⁰ capabilities within the Department of Defense as depicted in Table 1. The Air Force is uniquely trained and equipped to maintain aerospace forces and to understand the full range of applications those forces can provide.

The national security interests of the United States continue to evolve. Specifically, the nation’s interests in space have expanded and will continue to do so. The country's

Table 1. Air Force Percentage of DoD Air (Fixed Wing) and Space Capabilities

	Air (Fixed Wing)	Space
Personnel	82 %	90 %
Budget	73 %	85 %
Assets	75 %	86 %
Infrastructure	78 %	90 %

growing investment in, and reliance on, space-based capabilities that support the national information and commercial infrastructure are creating an economic¹¹ and military center of gravity—a vulnerability that, if exploited, could adversely affect the nation.

For the next quarter century, most aerospace objectives will seek to shape the geopolitical environment and neutralize security threats on Earth's surface. But, as more spacefaring countries emerge and technology advances, the potential for threats from and in space will increase. Space control will become a required capability of our Air Force.

Controlling the Aerospace Continuum

In the past, controlling the aerospace continuum meant control of the air. Our unparalleled success in achieving air superiority prevents adversaries from operating effectively against our surface and air forces and ensures our own freedom of action and maneuver.

Today, many see space as a sanctuary from military activity, free of interference. But just as exploiting the sea and air for military advantage led to military competition in those arenas, exploiting space will likely result in military competition in space. The status of space as a sanctuary may come to an end.

Control of the entire aerospace continuum is increasingly a prerequisite for effective joint operations. Growing threats such as cruise missiles, theater ballistic



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missiles, and hostile space assets, as well as our own growing dependence on commercial space services, present new challenges to joint operations. To achieve control of the aerospace continuum, the Air Force will complement its capability to control the air with an equally robust capability to control space. The appropriate level of space control will provide for friendly situational awareness, protection of our assets and our abilities to exploit space, prevent adversaries from relying on U.S. or allied space capabilities, and negate the ability of potential adversaries to use their own space capabilities.

Our Service will pursue treaty compliant technologies and capabilities to counter an adversary's space systems and services. Our preferred approach is tactical denial of an adversary's space-based capabilities to include localized, temporary, and reversible effects. These effects can be accomplished through the employment of air, ground, space, or information operations capabilities. And, our Service is committed to ensuring, with our defense and other agency partners, that our nation has the breadth of capabilities required for



Full-Dimensional Protection of our vital national interests in space.

Exploiting the Aerospace Continuum

Since its inception as a separate military service, the Air Force has demonstrated its abilities to exploit air and space to achieve operational objectives. For a long time, however, the development of air and space capabilities occurred largely independently of one another. Gradually, it became evident that by exploiting the combined capabilities of air and space platforms, greatly increased effects could be achieved. In the past fifteen years, the barriers between air and space planning and operations have substantially diminished. Aerospace integration—with its objective of producing effects without regard to where platforms reside—has been accelerating in the past decade. Our challenge is to ensure that aerospace integration keeps pace with the rate of change occurring in air, space, and information technologies.

Attributes of Aerospace Power

Aerospace integration finds its basis in our doctrine. The attributes of aerospace power—speed, range, perspective, precision, and three-dimensional maneuver—benefit from the synergies of integrating air and space capabilities.

Speed — The ability to move rapidly across the theater of operation and achieve effects quickly. Through the integration of air, space, and aerospace systems,

we can identify and attack mobile or concealed targets with breathtaking speed. The speed of our operations can overwhelm adversaries unable to keep pace.

Range — The ability to project power over great distances. The integration of air and space capabilities vastly expands the potential range of our forces and allows us to achieve objectives from greater distances or from orbit.

Perspective — The ability to perceive both friendly and hostile activity at a distance and in context.

Commanders throughout history have sought to control the “high ground” because it provides perspective over the battlefield. Integrated aerospace systems combine the broad perspective of Earth provided by space-based platforms with the high fidelity of airborne platforms.



Precision — The ability to deliver discriminating, tailored effects. Highly accurate space-based navigation and timing systems, integrated with airborne platforms, already have increased dramatically the effective delivery of munitions anywhere and anytime. The ability to co-register targeting information in a common coordinate system will yield even greater precision.

Three-Dimensional Maneuver — The ability to threaten the enemy through the movement of forces in the aerospace continuum. From its inception, airpower has presented

the enemy with the dilemma of defending against forces that fly over or around surface defenses.

Through maneuver in the third dimension, aerospace forces bypass traditional tactical and operational barriers and even terrestrial notions of sovereignty to pursue strategic, operational, and tactical objectives.

Tenets of Aerospace Power

Air Force doctrine defines seven tenets for the employment of air and space power.¹² Air and space power:

- Requires centralized control and decentralized execution;
- Is flexible and versatile;
- Produces synergistic effects;
- Is uniquely suited to persistent operations;
- Achieves concentration of purpose for operations;
- Demands prioritization of operations; and
- Requires that operations be balanced.

These fundamental aspects of Air Force doctrine are made more powerful through the integration of air and space capabilities.

For example, the real-time combination of radar and infrared sensor data from air and space platforms tracking ballistic missiles produces a synergistic effect. It provides a more accurate and timely intercept solution than could be achieved with either air- or space-unique collection techniques.

Integrated intelligence, surveillance, and reconnaissance (ISR) systems that incorporate sensors in space, in the air, and on the ground are becoming the



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standard for global ISR capabilities. By combining the strengths of broad area coverage satellites with the focused coverage of airborne assets, the Air Force is providing more accurate and timely information to the warfighter.

In Operation Allied Force, our U-2s flying over Kosovo and Serbia relayed their data via satellite in real time to the United States. By using reachback, the Air Force was able to concentrate its scarce linguists and imagery analysts in the United States, using their specialized equipment to transform raw data into finished information disseminated back to European commanders.

The development of Real-Time-Into-the-Cockpit (RTIC) information capabilities has taken integrated ISR a step further. RTIC conveys perishable battlespace information directly to the cockpit, enabling aircrews to take advantage of new target opportunities while avoiding new threats. This concept has become a reality with the Multi-Source Tactical System (MSTS) and Track II systems that provide satellite communication links to en route aircraft. These systems enable flex targeting, which is the ability to change the target assignments of aircraft while airborne, used so effectively during Operation Allied Force.

Progress in Aerospace Integration

The Air Force is building a full spectrum aerospace force through the integration of air and space people and systems. Today's Air

Force is well prepared in the 21st Century as an aerospace force.

In the area of education and training, the Air Force has initiated the Aerospace Basic Course (ABC) at Air University. As the first introduction to aerospace power studies, the ABC lays the foundation of aerospace concepts and understanding that will shape the culture of tomorrow's force. Air University has also developed a comprehensive Continuum of Education to address existing Professional Military Education and formal training regimens required to develop the next generation of aerospace warriors.

Another milestone for aerospace education and training was the establishment of the Space Warfare Center (SWC) in 1994—the counterpart to the Air Warfare Center. The centers work together to develop tactics, techniques, and procedures for better warfighting capabilities. The Air Force also established the Weapons School Space Division in 1995 to provide intensive, graduate-level education for space and missile operations officers. Today, the graduates of this course, like other weapons school graduates, are some of the most sought after people for our AOCs.

In an effort to improve the combat effectiveness of AOCs, the Air Force has also established the Aerospace Integration Center at Nellis Air Force Base. This is a significant step toward standardizing the AOCs as a weapon system, with a goal of ensuring

proper training, certification, and management for air, space, and information-credentialed, AOC-assigned personnel.

Despite reductions in its overall budget, the Air Force has maintained a high level of investment in space operations. While the Air Force budget has fallen by nearly half, spending on space has actually grown over the decade. To posture for the future, the Air Force is dedicating more of its science and technology (S&T)

investment to space and aerospace projects. By 2005, the Air Force will dedicate 55 percent of its S&T budget to such efforts.¹³

The programs and developments listed here are just a few of the many integration activities within the Air Force. Yet, they share a common characteristic—a focus on achieving the mission rather than focusing on a particular medium or weapons system.

3. AEROSPACE FORCES FOR THE JOINT TEAM AND THE NATION

You cannot do space in isolation of the other things you do. To isolate it would be militarily incorrect.
—General Michael E. Ryan, USAF Chief of Staff, 1999

Since its inception, the Air Force has evolved and adapted to a changing world environment and to advancing technology. We provide the nation and the joint team global vigilance, reach, and power. Aerospace integration holds the potential for enhancing the ways in which we execute our Core Competencies. The result will be better warfighting capabilities for the JFC, the National Command Authorities (NCA), and the nation.

Aerospace Integration Advances Air Force Core Competencies

In *Global Engagement: A Vision for the 21st Century Air Force*, the Air Force defines its six Core Competencies, describing the capabilities our Service provides the joint team. As our Service continues to merge evolving air and space capabilities, our Core Competencies will also evolve.

Aerospace Superiority — The Air Force has continually established superiority in the vertical dimension to provide the joint team freedom from attack, freedom of maneuver, and freedom to attack. In yesterday's threat environment, enemy air attacks created the need for air superiority. Today, the ability to control both air and space is vital to joint operations.

The foundation for achieving aerospace superiority is comprehensive battlespace awareness of both enemy and

friendly forces. Air- and space-based ISR capabilities and associated communication links underwrite our battlespace awareness. To make aerospace superiority a reality, we need the capability to control both air and space.



To control the air, the Air Force will soon deploy the F-22 Raptor. This high performance fighter aircraft will do much to guarantee U.S. control of the skies. The F-22 is not just an airborne platform, but an aerospace system comprised of the aircraft itself, off-board support, and a ground-based infrastructure developed to use the F-22 to its utmost effectiveness.

For space control, one leading concern is the proliferation of ballistic missile technology. An increasing number of nations threaten U.S. and allied forces as well as the U.S. homeland with missile attack. The integration of airborne and space-based detection systems with directed energy weapon systems such as the Airborne Laser and the future Space-Based Laser are key to countering this threat.



Today, we are developing advanced systems such as the Space-Based Infrared System (SBIRS) that will enhance our space surveillance capabilities, the first step in space control. In the future, we will need capabilities to protect our space assets, to prevent their use by our adversaries, and to negate the space capabilities of our adversaries.

Global Attack — Air Force long range bombers and intercontinental ballistic missiles supported the Cold War strategic balance. Today, these forces continue to play an essential deterrent role in the National Security Strategy.

As permanent forward basing becomes more uncertain, rapidly deployable, U.S.-based forces are assuming greater responsibilities in today's security environment. The ability to project power quickly across the globe with little or no notice gives policymakers a wider range of flexible deterrent and war-fighting options.



In Operation Allied Force, the Air Force demonstrated its global attack capabilities with the B-2 Spirit bomber. Flying from the United States to Serbia, releasing precision munitions in any weather condition, day or night, and returning safely to the United States, the B-2 exemplified the attack capabilities

available to U.S. forces anywhere on Earth.

In the future, the power projection capability of long range aerospace assets are likely to grow in importance in response to the increasing threat of missiles, weapons of mass destruction, and terrorism. Integration will present new opportunities for aerospace forces to maneuver within the entire vertical dimension providing an array of long range air and space capabilities.

Rapid Global Mobility — Mobility assets are vital to the constant flow of supplies, equipment, and other resources from the United States and allied nations to the theater of operations. The integration of air and space has yielded new capabilities for Air Force mobility forces.



Air Mobility Command uses In-Transit Visibility (ITV) to provide the JFC with situational awareness of deployed and en route personnel and equipment. ITV is a tracking system for monitoring cargo and personnel movements which uses radio, telecommunications, and communications satellites.

Consistent with the Expeditionary Aerospace Force (EAF) operational concept, our forward forces will rely on reachback

capabilities to sustain them while maintaining a smaller footprint forward. Future aerospace mobility assets will expand our capability further to move resources into and through space as well as the air.

Precision Engagement — Since the advent of air bombardment, the value of precision strike has become increasingly apparent—it puts fewer Americans at risk, reduces collateral damage, and decreases total costs. The combination of space-based navigational and timing services with precise weapons guidance is making the promise of airpower's precision strike an aerospace power reality.

Precision engagement has the potential to take aerospace campaigns to new levels of effectiveness. By combining precision strike with new methods of advanced planning and targeting, our aerospace force will offer even more effective capabilities to the joint team. Aerospace integration facilitates effects-based targeting and nodal analysis, leading to substantial advancements in warfighting.¹⁴

A comprehensive approach to precision engagement is the ability to find, fix, assess, track, target, and engage (F²AT²E) targets of military significance. The combination of real-time data, target analysis, precision weaponry, and rapid execution is advancing our ability to engage the right target at the right time.

Information Superiority — The military has always acknowledged the importance of accurate and

timely information for the decisionmaker and the warfighter. Today's Air Force supports a vast array of information collection, processing, and analysis capabilities. We provide information to the NCA, JFCs, warfighters, and even to weapons in flight.

One new capability is the use of electronic target folders to prepare aircrews for strike missions. These folders use all-source imagery data from air- and space-based platforms, in combination with precise geographical references made possible by GPS, to create the high-fidelity mission preparation materials used in Operation Allied Force.

Information superiority is critical to joint operations. In the future, our Service will seek to support the joint team by contributing to information dominance. The Air Force will exploit air, ground, space, and future aerospace platforms to provide timely and accurate information to our national leaders, JFCs, and operational units and forces. Additionally, we will no longer rely on the stove-piped processing, exploitation, and dissemination functions for each separate air and space sensor. Instead, we will field a system-of-systems enabled by the global information grid that fuses data from air, ground, and space-based sensors and prepares the information for use by the warfighter.

Agile Combat Support (ACS) — This Core Competency provides commanders with improved responsiveness, mobility, and



sustainability of their forces. Improving the responsiveness, deployability, and sustainability of Aerospace Expeditionary Forces is critical to the Air Force's global vigilance, reach, and power contributions; the integration of air and space makes this possible. For example, our Service's satellite communications infrastructure enables the use of telemedicine in support of deployments. During operations in Bosnia, telemedicine reduced time-to-treatment by more than 25 percent and reduced the need for many costly medical evacuations. Our future combat support team will tackle similar challenges to minimize lift requirements, footprint, and force vulnerability.

Aerospace Forces and the Joint Team

The Air Force makes significant contributions to the joint team. From nuclear deterrence to humanitarian relief, our Service applies global vigilance, reach, and power capabilities to the security concerns of the United States in theaters as diverse as Korea, Iraq, and the Balkans. Changing the way

Expeditionary Aerospace Force

The EAF operational concept reorganizes Air Force combat forces by operationally linking geographically separated units to form ten Aerospace Expeditionary Forces (AEFs). Each AEF consists of a powerful complement of air and space assets with manpower drawn from active-duty, Air National Guard, and Air Force Reserve components of the Total Force.

we operate, by implementing the Expeditionary Aerospace Force concept, will also sustain the Air Force contribution to the joint team.

Another example of how aerospace operations supports the joint team is the Air Force's role in providing space services. From space launch to precise navigation and timing data, the Air Force is leading the U.S. military space community into the 21st Century. The Air Force invests a substantial portion of its resources on space services for the joint team. Combining air and space capabilities may reduce overall costs.

A third example is Air Force participation in Joint Experimentation. The innovation and technology that the Air Force is pursuing expands both our own capabilities and the capabilities of our sister Services. Various initiatives tested in 1999 include en route retasking of aircraft weapons platforms, intelligence preparation of the battlefield, and integrating the Space Tasking Order with the Air Tasking Order.

Aerospace Nation

We in the Air Force believe that our future will require partnerships—among federal agencies, between the federal and state governments, and between all layers of government and industry.

—F. Whitten Peters, Secretary of the Air Force, 1999

Although the joint employment of aerospace power in support of national security objectives will continue to be our primary focus, we realize that aerospace power also

enables other instruments of national power. Aerospace power gives the United States an edge in shaping the battlespace, promoting U.S. economic and security interests, and influencing international events.

Each partner we have within the broader aerospace community, from NASA and the Federal Aviation Administration (FAA) to commercial firms and the intelligence community, has its own unique and special responsibilities. Aggressive partnering will allow us to leverage each other's capabilities to enhance our missions while decreasing redundancies. These partnerships will create the synergies we need to cultivate national aerospace power.

Aerospace Forces Support Civil Operations

Aerospace forces support civil operations in a number of ways, from providing weather data to partnering with the FAA on safety issues and NASA on the cost of space launch. For example, the Air Force is actively supporting a program that will offer lower launch costs—NASA's next generation Reusable Launch Vehicle (RLV).

Another cooperative effort is the Space Technology Alliance. It brings together the talents of each of the Services as well as NASA, the National Reconnaissance Office (NRO), and the Department of Energy to coordinate the development of affordable, effective space technologies. The result is coordinated research that uses limited resources effectively. The Space Technology Alliance is currently fo-

cus on the areas of space power, hyperspectral imagery, and micro-satellites among others.

Aerospace Forces and National Security

Aerospace forces support national security and military strategies. The Air Force produces timely air- and space-based sensor information for the NCA in partnership with the intelligence community. Aerospace forces also assist in treaty verification and non-proliferation activities. The Air Force and the NRO have long been mission partners in the exploitation of space for national security purposes. These two organizations have pioneered virtually all of the technologies and system designs responsible for the preeminent position the United States enjoys in national security space activities. Together, the Air Force and NRO account for over 90 percent of the people and funding allocated to space systems within the DoD. As they have for almost 40 years, Air Force officers, enlisted, and civilians hold key positions throughout NRO acquisition and operations. Since the earliest days, the Director of the NRO has been a senior Air Force civilian. Today, the Director also serves as the Assistant Secretary of the Air Force (Space), helping to ensure a close relationship between Air Force and NRO concepts of operation and future plans. As a direct result of that collaboration, the resources of the intelligence community space systems play an increasingly important role in direct support of military operations. As



the United States moves into the 21st Century, cooperation among the Air Force, the NRO, and the other intelligence organizations will become even more important.

Aerospace Forces and Commercial Applications

Tomorrow's aerospace force will also engage with commercial aerospace. Our Service will rely more on the commercial sector for services that are better or cheaper than those we provide organically. Similarly, we will rely on the abundant talent in research, development, and operations that reside in the commercial arena.

Air Force laboratories are partnering with "collaborative associates" in government, academia, and industry. The laboratories team with these associates to get a proper cross-section of skills and backgrounds. For example, each laboratory may augment its work force of career civil service employees by calling on a local university to gain access to graduate students and post-doctoral fellows. The laboratories may also approach world-class researchers for specific projects.

One specific project that has benefited from such cooperation is the development of the Evolved Expendable Launch Vehicle (EELV). The EELV will lead to lower launch costs for both the Air Force and the commercial sector. By partially funding the development costs, the government expects to have greater flexibility in the launch market while assisting the U.S. commercial sector in providing less expensive, more

responsive, and more reliable access to space.

Bringing It All Together—National Aerospace Power

National aerospace power is the application of air and space capabilities from the national security, civil, and commercial aerospace communities to achieve U.S. security objectives and promote U.S. interests. Today, there is a growing interdependence among the different aerospace communities. Each contributes greatly to national aerospace power by maintaining an industrial base for present and future aerospace capabilities, creating the political and diplomatic backdrop for favorable international negotiations on air and space issues, developing dual-use technologies and systems, and providing critical intelligence information necessary for decision making throughout the U.S. Government.

Committing to Aerospace Integration

We will continue our integration efforts to provide forces to the joint team and the nation. We have identified a few important actions to undertake in the next few years to further integrate our air and space capabilities and develop our people's ability to exploit innovative technologies, conceive strategies, and employ aerospace systems to solve the military challenges for the NCA. Ranging from new training and experience opportunities for our people to enabling analytical air and space system trade-offs, these actions will build on the foundation of

the full spectrum aerospace force we are working so hard to establish.

- We will provide career broadening opportunities for our people, developing an aerospace mindset throughout the Air Force. Specific tasks under this action include expanding the operational roles of space personnel at theater AOCs, creating opportunities for rated officers to experience operational space tours at mid-level career points, and offering assignments at UAV operational units for space personnel.
- We will expand aerospace education and training for our enlisted members to ensure they understand their contribution to our aerospace force. With increased knowledge of aerospace operations and support, our enlisted personnel will be better able to generate new ideas and support warfighting.
- We will establish the theater AOC as a weapon system, analogous to air and space platforms. This action captures the integrated operational concept proven in Operation Allied Force. It standardizes the mission, system requirements, operator procedures, concepts of operation, and combination of air, space, information, and battle management personnel for future warfighting.
- We will broaden the training of our Joint Force Aerospace Component Commanders (JFACC) to include specific aerospace education and field experience. We will also offer this training to

space, information, and battle management personnel.

- We will field a data fusion system to support AOC functions by fusing aerospace ISR data, exploiting distributed networks, building a comprehensive view of the battlespace, and providing near real-time inputs for existing battle management systems. The goal of this system will be to leverage existing capabilities in providing better situational awareness for all warfighters.
- We will develop dynamic space capabilities for exercises and wargames to train our personnel in the use and limitations of our existing and future aerospace capabilities.
- We will improve the ability of our acquisition community to evaluate ground, air, information, and space options based on military performance, cost, and effectiveness. This action will include the development of standardized measures of performance and effectiveness that do not depend on where a given platform or system resides. The result will be analytical tools we can use to develop an optimal mix of air and space systems to accomplish our assigned missions and improve our warfighting capabilities.

These actions, and more that will be in the Aerospace Integration Plan, will further our progress in aerospace integration. The Air Force is committed to taking these actions as it continues to build a full spectrum aerospace force.

4. OUR AEROSPACE FORCE

National safety would be endangered by an air force whose doctrines and techniques are tied solely to the equipment and processes of the moment. 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.

—General Henry “Hap” Arnold, Commanding General, Army Air Forces, 1945

The fundamental interests of the United States have evolved since the Air Force became a separate service in 1947. In the past, changes in national priorities required the Air Force to adapt rapidly. Our predecessors responded aggressively and set a course to protect and defend our nation’s interests. The Air Force will continue to meet this responsibility by further developing the foundation of our future aerospace force.

Predicting specific capabilities 25 years into the future is decidedly risky business. While most of today’s platforms have not changed markedly from their predecessors of the mid-1970s, how they are employed in conflict today bears little resemblance to that earlier era. Spurred by enormous advances in intelligence gathering, computer processing power, communications and data links, and advanced aerospace sensors, today’s tactics, techniques, and procedures have evolved in ways almost unimaginable 25 years ago. Those advances in the command and control of aerospace forces are expected to accelerate even faster in the coming decades. Despite our inability to precisely define future concepts of operation, the Air Force envisions future aerospace capabilities that are far more advanced than those we possess today.

Five specific areas exemplify the capabilities the Air Force will need in the 21st Century: battlespace awareness, long range precision strike, missile defense, information warfare, and aerospace operations.

Battlespace Awareness

Today, the Air Force has a very robust capability to focus both air and space ISR assets on a theater of operation to provide rapid targeting and assessment capabilities for the JFC. Battlespace awareness was clearly demonstrated during Operation Allied Force using the synergistic combination of aircraft, UAVs, satellites, commercial assets, and advanced data processing capabilities.

In the future, protection of our nation’s interests may demand battlespace awareness in multiple regions simultaneously. This will place a higher demand on our limited resources as we continue to seek target-quality data. Therefore, our Service will need integrated capabilities that take full advantage of the respective strengths of air and space. We will strive to automate and accelerate our capability to process sensor observations, exploit data, and disseminate information faster. To realize these capabilities, our Service will develop key technologies that include automated data fusion and target recognition,



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cross-cueing of all aerospace sensors, robust high bandwidth communications, and employment of spectral sensors at all relevant wavelengths.

These breakthroughs in operational capabilities are not the exclusive domain of the United States. The proliferation of information technology can erode our advantages in information operations and strategic deterrence while fostering new capabilities for our adversaries. The availability of high-resolution commercial imagery makes the movement and location of U.S. and allied forces more difficult to conceal. We must remain aware that our adversaries can view the battlespace and will use that information to threaten our forces.

Long Range Precision Strike

Our aerospace forces achieved tremendous success with long range precision strikes during the Gulf War and during Operation Allied Force. As we improve these capabilities, our scientists, engineers, and operators are working with NASA and the Defense Advanced Research Projects Agency (DARPA) to develop advanced propulsion technologies. These developments promise operations at hypersonic speeds and transatmospheric altitudes. Other advanced vehicle designs with rocket engines could lead to reusable aerospace vehicles with the capability of striking from an orbiting platform. Consistent with national policy and potential deployment decisions, our future aerospace leaders will have the opportunity to select the best

combination of engines, platforms, weapons, and concepts of operations to enhance long range precision strikes.

Missile Defense

Today, the Air Force is making critical contributions to the joint team's theater and national missile defense capabilities. Our Service operates Defense Support Program satellites and ground-based radars that detect virtually all cross-border ballistic missile launches. We are developing an Airborne Laser to destroy ballistic missiles in flight, relying on the capability to fuse missile tracking data from air and space sensors. In the future, the Air Force will field and operate more advanced SBIRS satellites and continue to develop the Space-Based Laser to defend against ballistic missile attack.

Information Warfare

The Air Force has taken steps to use information warfare in today's battlespace. In terms of electronic warfare and protection, the Air Force has developed robust capabilities to achieve dominance with such assets as High-Speed Anti-Radiation Missiles, protection pods for our non-stealth airborne platforms, and off-board cueing of electronic threats based upon air-, space- and ground-based collection platforms. Our Service will continue to pursue electronic warfare initiatives to counter future threats.

Within cyberspace or the global information grid, the Air Force is developing information attack and assurance capabilities to achieve ef-

fects at all levels of conflict. However, cyberspace and its related technologies are evolving rapidly, and this presents both new opportunities and vulnerabilities for our Service. In the future, our leaders will have to consider investment tradeoffs between cyber and aerospace capabilities to achieve desired effects.

The Air Force possesses robust computer, communications, and network expertise that can be used for information attack. Thus, we will train our future aerospace commanders to employ information warfare as another tool to achieve effects for the joint team.

Aerospace Operations

In the future, the nation's challenges will require new and advanced technologies. These capabilities include aerospace mobility, space control, and the possibility of force application from space.

Space launch remains an expensive aspect of aerospace operations. The Air Force is playing a major role in both the EELV and RLV programs to reduce the cost and increase the reliability of space launch vehicles and infrastructure. Tomorrow's global mobility capabilities, both in the air and through space, will be vital to our operations wherever they may occur.

Space-based capabilities such as ISR, navigation and timing, communications, and weather data are critical to joint operations. In the future, they will become targets for our adversaries. Space operations—access and control—will be

necessary to sustain our advantage. We will become experts in space control. Our abilities to control space, protect our space assets, and dominate throughout the aerospace continuum will help define our role within the joint team of the next century.

In fact, U.S. Space Command has long been assigned the planning responsibility for space weapons. In order to ensure proper preparedness should our civilian leadership later decide that the application of force from space is in our national interest, the Air Force will continue to invest in technology development as permitted by national policy.

Serving in an Aerospace Force

As our Service continues its journey, we need to sustain our progress and move toward a common aerospace vision. We will strive to attain an aerospace force with the following characteristics:

- The aerospace force supports operations within the entire aerospace continuum, through the skillful employment of aerospace power using new and innovative capabilities;
- Aerospace doctrine is understood, embraced, and effectively employed by all of our aerospace warriors;
- People are effectively trained with wargames, simulations, and exercises that incorporate both our own and our adversaries' dynamic and realistic aerospace capabilities;



- Aerospace culture permeates the force in the education, training, policy, and most importantly, in the minds of our airmen. Our personnel think in terms of controlling and exploiting the aerospace continuum to achieve effects both on Earth and beyond;
- Broad thinking, widely experienced aerospace officers, non-commissioned officers, and civilians lead the aerospace force. Our future Air Force and joint leaders are proficient in the application of all aspects of aerospace power. These leaders will be versatile and highly skilled aerospace personnel promoted for their potential as aerospace commanders;
- The Air Force continues to foster an atmosphere that supports innovation. Personnel experienced in aerospace power will develop new technologies, systems, training methods, concepts of operations, and organizations that will move the Service closer to a full spectrum aerospace force;
- The aerospace force is organized to conduct joint operations within the entire aerospace continuum. Major elements of our force are organized according to the functions or disciplines they perform within our Service and not by the medium in which they operate. Artificial barriers between air and space organizations diminish, and efforts continue to ensure individuals routinely move among multi-functional aerospace assignments as their careers progress;
- The aerospace force is equipped with systems designed to achieve effects at all levels of conflict. These systems are interoperable with, and integrated into, architectures that support the creation of lethal and nonlethal effects;
- Leaders make resource decisions based on capabilities that produce the desired military effects—regardless of where platforms fly, orbit, or reside;
- Aerospace warriors have attained mastery of the full range of aerospace capabilities for the joint team; and
- The aerospace force is cooperatively engaged with our sister Services and allies, the intelligence community, and broader aerospace interests that include commercial aerospace, civil agencies, and international aerospace activities.

While the exact nature of tomorrow's aerospace force is difficult to predict, we know that the days of separate air and space forces are over. We are an aerospace force that will look to—and prepare for—the future.

5. MEETING THE CHALLENGE

The talent, dedication, patriotism, and spirit of our men and women transform our aircraft and space systems into the most competent, powerful aerospace force the world has ever known.
—F. Whitten Peters, Secretary of the Air Force, 1999

The challenges of aerospace integration are being met with careful planning, decisive action, strong leadership, and individual commitment. The journey toward a full spectrum aerospace force requires the support of the entire Air Force family. Because this effort is so important, you must be an active participant in the process. Aerospace integration is as much your own as it is the Air Force's endeavor.

Though aerospace integration has been ongoing, the Air Force is developing an Aerospace Integration Plan that identifies near-term, high-leverage actions to further the proc-



ess. These actions will focus on new employment concepts and doctrine, people and culture, organization, equipment, and resources. Achieving our goal also will require that the Air Force master the full range of aerospace capabilities and that we reach out to the broader aerospace community to ensure that our forces meet the needs of the nation.

Achieving a full spectrum aerospace force requires the

understanding, support, and enthusiasm of the men and women serving in the Air Force today and tomorrow. In return, the Air Force senior leadership will encourage and respond to your ideas and efforts so that together we can improve our Service.

The most important objective of *The Aerospace Force* is to affect the ways in which you, the Air Force professional, think about aerospace power. As you reflect on the ideas expressed within this paper, and identify new steps to take, you are participating in the realization of our aerospace vision.

We are on a journey, combining evolving air and space competencies into a full spectrum aerospace force. In doing so, we will remain loyal to our core purpose as a military institution—to be a force that enhances our nation's joint warfighting capabilities and continues to guarantee the security of the United States in peace and in war. Come join with us. Working together we can make the Air Force stronger and provide a better defense for our families and our nation.

ENDNOTES

¹ A Joint Force Commander is a general term applied to a combatant commander, subunified commander, or joint task force commander who exercises combatant command authority or operational control over a joint force. U.S. Department of Defense, Joint Chiefs of Staff, JP 1-02, *DoD Dictionary of Military and Associated Terms*, As Amended through 10 February 1999 (Washington, D.C.: Joint Staff, 1999), pp. 100, 254, and 466.

² The White House, *A National Security Strategy for a New Century* (Washington D.C.: U.S. Government Printing Office, 1998), p. 25.

³ U.S. Air Force, Air Force Doctrine Document 2, *Organizing and Employment of Aerospace Power* (Maxwell Air Force Base, Alabama: Air Force Doctrine Center, 23 September 1998), p. 1.

⁴ U.S. Department of Defense, DoD Directive 5100.1, *Functions of the Department of Defense and Its Major Components* (Washington, D.C.: U.S. Department of Defense, 25 September 1987) describes one of the unique functions of the Air Force as "...to provide launch and space support for the Department of Defense, except as otherwise assigned." The same document charges the Air Force to provide air and space forces for the effective prosecution of war and military operations short of war.

⁵ U.S. Air Force, Air Force Doctrine Document 2, *Organization and Employment of Aerospace Power*, p. 1.

⁶ U.S. Air Force Scientific Advisory Board, *A Space Roadmap for the 21st Century Aerospace Force*, by John Borky et al. (Washington, D.C.: U.S. Air Force, November 1998), p. 10. Kepler developed the laws of planetary motion, which form the foundation of today's orbital mechanics. Bernoulli studied pressure systems, establishing the foundation for the study of aerodynamics.

⁷ U.S. Air Force, Air Force Doctrine Document 2, *Organization and Employment of Aerospace Power*, p. 2.

⁸ U.S. Air Force, Air Force Doctrine Document 1, *Air Force Basic Doctrine* (Maxwell Air Force Base, Alabama: Air Force Doctrine Center, September 1997), p. 23.

⁹ U.S. Air Force, Deputy Chief of Staff for Plans and Programs. These statistics were generated during the second quarter of 1999 based upon the percentage of fiscal year 1999 funding allocated to fixed-wing aircraft capabilities.

¹⁰ U.S. Air Force, Deputy Chief of Staff for Plans and Programs. These statistics were generated during the second quarter of 1999 based upon the percentage of fiscal year 1999 funding allocated to space capabilities.

¹¹ The White House, *A National Security Strategy for a New Century*, p. 25. We are experiencing an ever-increasing migration of capabilities to space as the world seeks to exploit the explosion in information technology. Telecommunications, telemedicine, international financial transactions, entertainment, news, education, weather data, and navigation data all contribute to the U.S. economy, and all are dependent on space capabilities.

¹² U.S. Air Force, Air Force Doctrine Document 1, *Air Force Basic Doctrine*, p. 22.

¹³ U.S. Air Force Deputy Chief of Staff for Plans and Programs, *AFRL Investment by Category*, 22 February 1999.

¹⁴ Nodal analysis is a planning technique that relies on global awareness to identify vulnerabilities in an adversary's system-of-systems. This technique was successfully used to disrupt oil production during Operation Allied Force.

On the Cover

Drawing on the theme of “seamless aerospace,” the cover features historical and contemporary elements seamlessly blended into one strong statement of purpose.

The front cover features General Hap Arnold, who as Commanding General, Army Air Forces, commissioned the seminal study *Toward New Horizons* in 1944. To his right is a Delta II on its pad with the exhaust plume billowing beneath to silhouette General Jerome O’Malley standing below. General O’Malley, former Air Force Vice Chief of Staff, was both a pioneering SR-71 pilot and a tireless advocate of Air Force space programs. General O’Malley’s contemporary pressure suit is in marked contrast to the leather and goggles of a young Hap Arnold and another pilot standing to the left. The two pilots are superimposed over a drawing of an original flying machine, a glider patented in 1895 by aeronautical pioneer Otto Lilienthal. Above the pilots is a Jenny, legendary airplane of World War I in service from 1917 to 1927.

On the back cover, directly opposite the Lilienthal glider, is a schematic of Robert Goddard’s rocket that made its first successful flight in 1926. The diagram is superimposed over Goddard himself. Against a dramatic background of glowing planets, wispy nebulae and astral starforms are aircraft and space systems that represent milestones in aeronautical technology. Roaring onto the back cover are two F-22s in formation, flying above the curved horizon line that extends onto the front cover, partially silhouetted against the billowing white of an ICBM, whose plume curves gently into space. To the far left is an aircraft recovery of a Corona capsule, the first photo reconnaissance satellite program, operational from 1960 to 1972. Next is Chuck Yeager’s X-1, the first piloted aircraft to break the sound barrier, a feat accomplished in 1947. To the right of the ICBM plume are contemporary elements including an X-38 lifting body returning to Earth; a Predator unmanned aerial vehicle; a B-2 Spirit; and a GPS satellite.

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TURBINE
VALVE
VALVE

LIQUID
OXYGEN LINE

ROCKET MOTOR

ENTRANCE FIELD

TURBINE
CASE
TANK

PULL
CORD
CONTROL
LEVER

OXYGEN
PRESSURE LINE

A
UNIVERSITY
COLLEGE