Air Force and aerospace industry leaders have looked into the boundless expanse of space, recognizing the next frontier in military operations, and they describe the view as humbling. They can peer no farther into the space age than the Wright brothers could see into the era of flight from a windswept dune at Kitty Hawk in 1903. Few should doubt, however, that tapping the vast potential of space will require bold leadership and profound changes in the nature and culture of the Air Force.

That was the message delivered last November in Los Angeles at the Air Force Association’s national symposium “National Security: The Space Dimension.” Featured speakers included Air Force Chief of Staff Gen. Michael E. Ryan, who spoke of the challenges inherent in shifting from the air and space force of the present, to the space and air force of tomorrow. Gen. Howell M. Estes III, commander in chief of NORAD and US Space Command and commander of Air Force Space Command, stressed that the Air Force is at a critical crossroads in terms of its commitment to space exploitation and faces tough investment choices between weapons programs and critical space infrastructure.

Peter S. Hellman, TRW’s president and chief operating officer, noted that the nation must maximize the rewards of an ongoing revolution in business practices and processes to afford the costly exploration of space.

Space and Air Force

As a preface to his remarks on the challenges of becoming a space and air force, Ryan noted what many observers have called the acceleration of time. Driven largely by rapid-fire, exponential advances in computing power—which by the turn of the century will likely lead to computers capable of performing one trillion calculations per second—human knowledge is now doubling every 10 to 15 years.

“That means that we have gained as much new understanding of our world and its physical properties in the past 15 years as all the inventors in history and all the scientists in the past 5,000 years,” said Ryan. It’s amazing to think that man’s journey into powered flight began less than a century ago, and man has gone into and become dependent upon space.
just since most of us have been adults, he added.

Those warp-speed advances in technology and knowledge make it difficult, according to Ryan, to predict with any precision the impact of space exploitation technologies on military operations in the first quarter of the next century. Already, however, space has become an indispensable medium in the everyday lives of Americans. Space systems relay radio and television broadcasts, warn of dangerous weather patterns across the globe, provide expanded educational opportunities for people in isolated locations, and even help drivers navigate in automobiles.

The United States alone has more than 220 commercial, civil, and military satellites in active operation, with a combined value of over $100 billion. In one day, the Defense Department spends about $35 million on space programs.

The profound impact of space technologies on military operations has only become evident, however, in recent years. Six years ago, “we fought what has been called the first space-aided war, in Desert Storm. Our space-based capabilities were instrumental in the execution of the campaign that dismantled Iraq’s military capability. Since then we have seen more successes in integrating space into our operations in the Bosnia campaign, [where] I can tell you from firsthand experience that space systems were vital,” said Ryan. “They afforded us precision targeting, the capability to revisit those targets to avoid collateral damage, and contributed to the peace. ...”

Space systems and operations are now considered integral to all Air Force core competencies, from air superiority, long-range precision attack, and global mobility to agile combat support and information superiority. The concept of global situational awareness is by definition a largely space-based capability.

“In the future, we will achieve far better global situation[al] awareness as space capabilities become the primary means of information acquisition, processing, and distribution,” said Ryan. Already, information conduits in space are giving us so much data that the challenge is not throughput but information management, Ryan emphasized, adding, “so that we are not swamped by the quantity of [data] and [thus] miss the warnings and opportunities that are there.”

**90 Percent Solution**

More than any other service, according to Ryan, the Air Force has adjusted its doctrine and directed its resources to exploit that rapidly evolving space capability. The Air Force provides 90 percent of the military’s space budget, for instance, and 93 percent of space personnel. Despite a post–Cold War drawdown that has seen all of the services reduce their size by roughly a third, the Air Force satellite force has increased by 25 percent since 1991.

The Air Force has always been a responsible steward of space, stated Ryan. “Of the services, we alone have the expertise and we alone have made the investment.” And he noted, “We will continue to take the lead in organizing, training, and equipping our space forces.”

Key to Air Force stewardship of space is the service’s “Global Engagement: A Vision for the 21st Century.” That vision statement represents a commitment by the entire Air Force leadership to space as the next frontier in the aerospace continuum.

With release of that document, “the Air Force made a major commitment to the role of space in our future,” said Ryan. “Our goal is to eventually evolve from an air and space force, which we call ourselves today, into a space and air force.” He emphasized that that is a transition of enormous importance. “We must move beyond the stovepipes of separate space and air capabilities in operations to [operations] that are fully integrated and fully interwoven.”

An important step in that evolution is the recently published Air Force doctrine manual, setting out the service’s view of air and space forces and power. As part of that doctrine, deployed air operations centers will now include space experts in the strategy, plans, and operations cells. Under the operations concept spelled out in the manual, forward-deployed air and space expeditionary commanders will act as conduits for requests for national space assets and provide regional commanders in chief with a “one-stop shopping” point for air- and spacepower and expertise.

This growing reliance on space
capabilities to enhance military operations, however, will unavoidably lead to increased vulnerability to attacks on the space infrastructure. “Our dependency on space is growing, as well as the potential for threats to those capabilities,” said Ryan. He added that many nations now have access to sophisticated space resources, specifically communications and navigation. “The nations who observed how we used these capabilities very successfully will be motivated to find ways to prevent us from using them in the future.” For that reason, Ryan stated the Air Force has changed its traditional mission of air superiority to air and space superiority. “This will be very important as more of our military infrastructure moves from Earth to space, as well as is true with commercial enterprise.”

Though Ryan does not claim to have a clear vision of the coming space age, he sees enough promise in present trends to draw some far-sighted conclusions: This evolution toward a seamless system implies that space assets will conduct what we think of now as air missions, and perhaps vice versa. “There undoubtedly will be platforms that operate in both air and space: An air- and spaceship, a starship, an Enterprise. If we’re going to go there, the Air Force must remain on the cutting edge of science and technology.”

**Estes: At a Crossroad**

To cover the uncertain ground between the Air Force of today and a future starship Enterprise, the service will undoubtedly have to make several bold leaps of faith in space-age technology. The Air Force today stands at the precipice of just such a leap, according to Estes, the senior military commander of space forces.

He firmly believes USAF is at a crossroad. The Air Force faces “important, time-critical decisions that [it] will need to make to assure its vitality and relevance into the next century—decisions about who we are and what we will be in the times ahead.”

Estes stressed that the Air Force must not allow itself to be intimidated into taking the easy road by the demands of daily operations or immediate threats. There’s a natural human tendency toward conservatism—to stick with what we know, what we are comfortable with, and what has worked in the past, he said. “However, we must not become complacent in our conservatism,” he added. “There’s a balance, but ... we must overcome our fear of change and set a course to the future by taking [Robert Frost’s] road ‘less traveled by.’”

Certainly the Air Force has successfully negotiated such critical crossroads in the past. From the first hot air balloonists spying on enemy positions in the Civil War, those who argued the utility of airpower in military campaigns were often flying against the prevalent winds of conventional wisdom. In the years between the world wars, Estes noted, the airplane was viewed mainly as an extension of the Army’s ground campaign.

“[Army commanders] did not have the expertise, the vision, or incentive ... to discern [the airplane’s] awesome offensive striking power or its ability to be decisive in its own right, ... [and that] stifled the development of the airplane,” said Estes. “It took nearly four decades before the true potential of airpower was realized, in World War II, and another 40-plus years before this potential was implemented to what we think was near the fullest imagined extent in Operation Desert Storm.”

Estes believes the Air Force of today faces a quandary somewhat similar to that of the Air Corps in the 1940s. Constrained by declining budgets and doubted by many detractors, it has to fight for its vision of a seamlessly integrated air and space force and the power of aerospace forces.

“The Air Force has assumed the position of leadership and stewardship of the bulk of this nation’s military space capability,” said Estes. “[We] have labeled space superiority as one of our core competencies, but as of yet, we have very little means of ensuring space superiority. We don’t even know how to define it yet. But we’re working on it. ... This is the crossroad in history the Air Force has reached. ... Our actions regarding space over these next few years will set the course for the next quarter-century, and I propose we had better choose carefully.”

**Hard Funding Choices**

Charting a bold course will require that Air Force leaders make difficult decisions in terms of funding space programs and building a space-based infrastructure. Linchpin space programs now fighting for budget dollars include the Space-Based Infrared System, the Milstar satellite communications system, the Global Positioning System, and the Evolved Expendable Launch Vehicle. To leverage advances in space technology made in the civil and commercial sector, the Air Force also needs to form closer partnerships with private industry and organizations such as NASA and the National Reconnaissance Office.

“We need to restore funding to modernization of the launch ranges, ... [which] are eventually, in my opinion, going to become national space ports,” said Estes. “We need to maintain funding on the low segment of the Space-Based Infrared System to enable effective Theater Missile Defense systems. We need to develop real-time, full-cover- age, near-Earth space surveillance capabilities to enable our initial steps to do space control. ... We need to develop a real-time, space-based Earth surveillance system to provide the ‘dominant battlefield awareness,’ as set forth in [former Chairman of the Joint Chiefs of Army Gen. John M.] Shalikashvili’s Joint Vision 2010.”

For space forces to link all Joint forces as envisioned in Joint Vision 2010, Air Force leaders will have to perform a difficult balancing act in trying to robustly modernize both air and space forces. As budget pressures continue, Estes believes the Air Force will have difficulty adequately nurturing all of its core competencies.

“Hard choices need to be made between investments in information infrastructure or the combat systems,” said Estes. “We need to strike a balance between ‘shooters’ and ‘information systems’ if we are going to be successful in the future. However, I believe we must lean more in favor of finding ways to effectively use these new, rapidly expanding information systems for awhile.” He added that barring some unknown external source of budgetary assistance, the Air Force must make some internal adjustments “with the objective of revolutionizing our ability to gather, process, interpret, and act on information.”

If those hard choices are made, he said, “Someday in the not so distant
future, space will have evolved to the point where the movement of terrestrial forces will be accomplished only at the pleasure of space forces, much the same way that the movement of land and sea forces today can only be accomplished at the pleasure of air forces. Future battlefields will be made transparent by space surveillance systems—augmented by air, land, and sea surveillance systems. This transparency will lay bare the hostile intentions of potential adversaries.

Estes went on to say, “In each [space] command, I have young men and women with a tireless passion for space. ... While encouraged by the rhetoric of the Air Force’s long-range plan that speaks of moving from the Air Force we know today to an Air and Space Force tomorrow and, eventually, to a Space and Air Force in the future, their view is somewhat different. In their minds the Air Force is now, and has for some time been, an Air and Space Force. They can accept no description less and, in fact, neither can I. ...

“I am also sure the flyboys of old, so instrumental to the development of our Air Force, would support the view that the time for rhetoric has passed and we must replace it with action. We will never become an Air and Space Force if we do not begin to invest greater sums in space. It is not enough to maintain the given, fixed percentage of Air Force total obligation authority for space. Space must expand and become a larger part of the Air Force budget every year. It has to be this way because it is unlikely anyone is going to give the Air Force a bigger slice of the pie to cover our expansion into space.”

Hellman: “Lean” Thinking

To realize the lofty rhetoric of space visionaries, industry leaders believe they will have to continue an ongoing revolution in business reengineering and processes. Adopting this mindset of “lean thinking” is paramount if the Air Force and industry are to continually eliminate waste and maximize scarce space resources.

“The systematic transfer of lean thinking to space activities touches every task,” said TRW chief Hellman. “It changes management, organization, teaming concepts, standardization requirements, inventory handling, working empowerment, process mapping, and root-cause analysis. It always targets the elimination of waste.”

Hellman sees many parallels between the Air Force’s challenging push into space and the “dog-eat-dog” world of automotive competition. Automotive companies today, for instance, expect their suppliers to reduce prices by five percent each year. Given the rising costs of raw materials and labor, that means TRW and other automotive suppliers must realize annual efficiency gains of eight percent. They succeed through higher productivity, technological advances, and innovative designs.

“A little-known fact is that the end-of-the-line quality is higher in the automotive industry than in the aerospace industry,” said Hellman. “The quality is manufactured in, not inspected in. When your manufacturing quality is high, you lower your inspection, rework, and warranty costs. [That kind of reliability] is vital to the Air Force. ... Look at the lifetime the satellites are achieving today and the impact of such reliability on budgets and force structures.”

Other examples of lean thinking are evident throughout the aerospace industry. In its latest annual report, for instance, United Technology’s Sikorsky Group applied lean production techniques and realized a reduction of 70 percent on its spindle rejection rates, while cutting machining time by 57 percent.

Ramp Up, Ramp Down

In applying lean thinking to its engineering processes, TRW found that there was a start–stop–start cycle to its operations that caused its top engineers to constantly accelerate and then curtail their efforts. “We found that the productive power of our best engineering minds was sometimes on hold—a task that might require eight man-days of actual engineering work could be extended over a period of three weeks,” said Hellman. “This start–stop–start approach meant ramping up both mentally and physically many times over those weeks. It added time and cost. We reengineered that activity [and it] is now being applied to our space and defense work as well.”

There are also similarities in the push toward integrated product teams by both the Air Force and the auto-
motive industry. Especially in large organizations, the focus on IPTs leads to quicker cycle times and added agility. “Using IPTs, the automotive industry has gone from seven years in designing a new car to 21 months. The Air Force can point with pride to similar gains,” said Hellman. “A universal lesson learned is that smaller companies or companies with commercial roots have a built-in capability for fast action and quick inclusion of developing technologies. Large companies attain it by creating carefully focused internal groups.”

USAF might also benefit from the lesson of an automotive industry that has worked to open lines of communication and provide suppliers with constant feedback on their performance. Chrysler, for example, supplies TRW with a monthly report detailing exactly how it is performing in comparison with 600 other suppliers. The ratings are based on such factors as price, customer service, quality, delivery times, and warranty.

Hellman emphasized that having Chrysler tell TRW monthly where TRW stands is invaluable, because “they define the competitive landscape for us.” He said, “Industry could work with the Air Force to develop a Chrysler-style rating system that would tell us all where we stand as competitors. We want to know. ... The basic data for such an evaluation exist, at least in substantial part, in the Contractor Performance Assessment Report.” That would help industry see itself as the Air Force sees it, he added.

If the Air Force is to successfully transition into a space and air force, Hellman also believes it needs to give clearer coordinates to the aerospace industry. Confusion over the exact direction and pace of that effort on the part of industry will only weigh it down.

For historical reasons, USAF’s close-to-the-vest tradition concerning its long-range strategy still exists, according to Hellman. With the Air Force confronting this very different post–Cold War challenge, however, “I wonder if that tradition might not be modified. The better the industry understands long-range strategy, the better it can commit its own resources and best minds to the amplification and implementation of that strategy.”