The Honest Broker for Science and Technology

Dr. Mark J. Lewis, U.S. Air Force Chief Scientist

Dr. Mark J. Lewis has served as chief scientist of the U.S. Air Force since 2004. He provides assessments on a wide range of scientific and technical issues affecting the Air Force mission. In September 2006, Lewis spoke with Randy Zittell, professor of systems engineering at the Defense Acquisition University, about his vision for championing real experimentation and taking risks up front, and about ensuring a focus that promotes current technology while still keeping a firm eye on the long-term picture.

Q
The Air Force chief scientist exists in a purely advisory capacity, with an emphasis on providing an uncensored view of Air Force science and technology (S&T). With no programs to manage or budget to control, you're free to help the Air Force leadership in an unbiased capacity—a unique position among the Services. What are your duties, and what's the Air Force's vision for the position?

A
My job has several key roles. In many ways, I am the honest broker for science and technology. I am the person who is supposed to tell the chief and the secretary and the vice chief and the under secretary of the Air Force what we are doing right, what perhaps we are not doing right, what we are missing, and what we need to re-emphasize.

My favorite analogy for the role of chief scientist is from one of my predecessors, Dr. Michael Yarymovych, who was chief scientist in the 1970s and originated the idea of the Global Positioning System.

When I was starting this job, Mike said, "You know, you can read all the formal descriptions of what the chief scientist does—advising the chief and representing the Air Force—and that is all fine, but here's the way you think about the job: The chief of staff is the king, and the other generals are like the noblemen. The chief scientist is the court jester, whose role is to provide the scientific entertainment. But in the Middle Ages, the only person who could be honest with the king was the court jester. If others tried, their heads would probably get lopped off."

I have never yet had to explain to someone why investment in science and technology is important. Everyone in our leadership understands the concept of investing in the future.

Photographs by SSG Mason Lowery, USA.

So that's my job, to be honest with the chief. Sometimes I describe it as separating physics from PowerPoint®. When someone's trying to sell us a great concept—you know, an airship that is going to hover at 100,000 feet over one spot on the earth indefinitely and do everything we ever wanted—and everyone else is telling the secretary and the chief, "Wow, this is the greatest thing since sliced bread," I am the person who has to say, "Hold on a minute. This violates at least two or three laws of physics."

It is important, therefore, that I not have programs or people to manage because I need to make sure in my job that I don't have territory to protect.

Other aspects of the job stem from that role. One is that I am a science and technology advocate for the Air Force. I like to remind people that our founder, Hap Arnold [*Air Force Gen. Henry H. Arnold*], knew that the force he was envisioning had to be grounded in S&T. One of the first things he did was call a meeting with Theodore von Kármán, one of the greatest aerodynamicists of the 20th century. They had a conversation on Long Island—actually in Hap Arnold's staff car—in which Arnold told von Kármán that he wanted Air Force research to be tied into the pivotal scientific communities in the United States.

They called together a group that became known as the Scientific Advisory Group; it was the predecessor to our Scientific Advisory Board. They mapped out the future of Air Force technology, which became the "Toward New Horizons" study we all revere. That is a very powerful message: From day one, the Air Force was a science and technology Service that understood the need to draw on outside expertise to help guide that S&T. This office is really an extension of that.

Now here's the good news about my job: When I walked into this office, I thought one of my roles would be to remind our leadership about the importance of science and technology. I have never had to do that. I have never yet had to explain to someone why investment in science and technology is important. Everyone in our leadership understands the concept of investing in the future.

But having said that, I also sometimes describe myself as the S&T canary in the Air Force mine. I want to be the first alert if something is going awry. I want to be the person who picks up on the problem before it becomes a major issue. In that capacity, I see myself as a way to—for a lack of a better description—short circuit the chain of command on certain S&T issues. I represent a direct conduit to the very top levels of the Air Force in S&T matters. When a bench-level scientist or engineer working in the lab has a great idea or a concern, issue, or capability, I see myself as the way to really elevate that to the top level, if it is important enough.

Dr. Mark J. Lewis

Chief Scientist, U.S. Air Force

Dr. Mark J. Lewis serves as chief scientific adviser to the chief of staff and secretary of the Air Force, providing assessments on a wide range of scientific and technical issues affecting the Air Force mission.

Lewis received his professional education at the Massachusetts Institute of Technology, earning bachelor's degrees in aeronautics and astronautics, and in earth and planetary science; a master's degree in aeronautics and astronautics; and a doctorate. He is currently on leave from his position as professor of aerospace engineering at the University of Maryland and director of the Space Vehicles Technology Institute, College Park, Md. For the past 19 years, Lewis has conducted basic and applied research in and taught many aspects of hypersonic aerodynamics, advanced propulsion, and space vehicle design and optimization. His work has spanned the aerospace flight spectrum from the analysis of conventional jet engines to entry into planetary atmospheres at hypervelocity speeds. A frequent collaborator with both government and industry, his research activities have contributed directly to several NASA and Department of Defense programs in the areas of high-speed vehicle and spacecraft design.

Lewis is the author of more than 220 technical publications and adviser to more than 50 graduate students. He is active in national and international professional societies, with responsibilities for both research and educational policy and support. In addition, he has served on various advisory boards for the Air Force and DoD, including the Air Force Scientific Advisory Board, where he participated in several summer studies and chaired a number of science and technology reviews of the Air Force Research Laboratory.

Another role is as the representative of Air Force S&T on the outside, interacting with our sister Services and with NASA. I can point to NASA, especially, as one of our real good-news stories over the last year-and-a-half. We have a new NASA administrator who is very keen on interaction through the Department of Defense. We've been doing a number of joint activities in an effort to make sure our programs are in line, that they don't overlap, and that we advance mutual interests in S&T.

Q

As part of a focus on experimentation instead of demonstration for introducing new technology, you've said that taking the risks up front, even before acquisition begins, will not only lower total program costs, but also allow the introduction of technologies and solutions. Would you expand on this idea?

A

One concern I had coming to this job is that I think, to a certain extent, the Air Force and the DoD—and in fact the United States in general—are too much in the mode of demonstration as opposed to real experimentation. Let me draw the important distinction because sometimes when you tell people you're against demonstration, they respond, "Oh—you're against flight test," and of course I'm not, not at all. I'm a big fan of flight test. I think we should do more flight tests, more experimental vehicle types of things, in addition to modeling and simulation and ground tests.

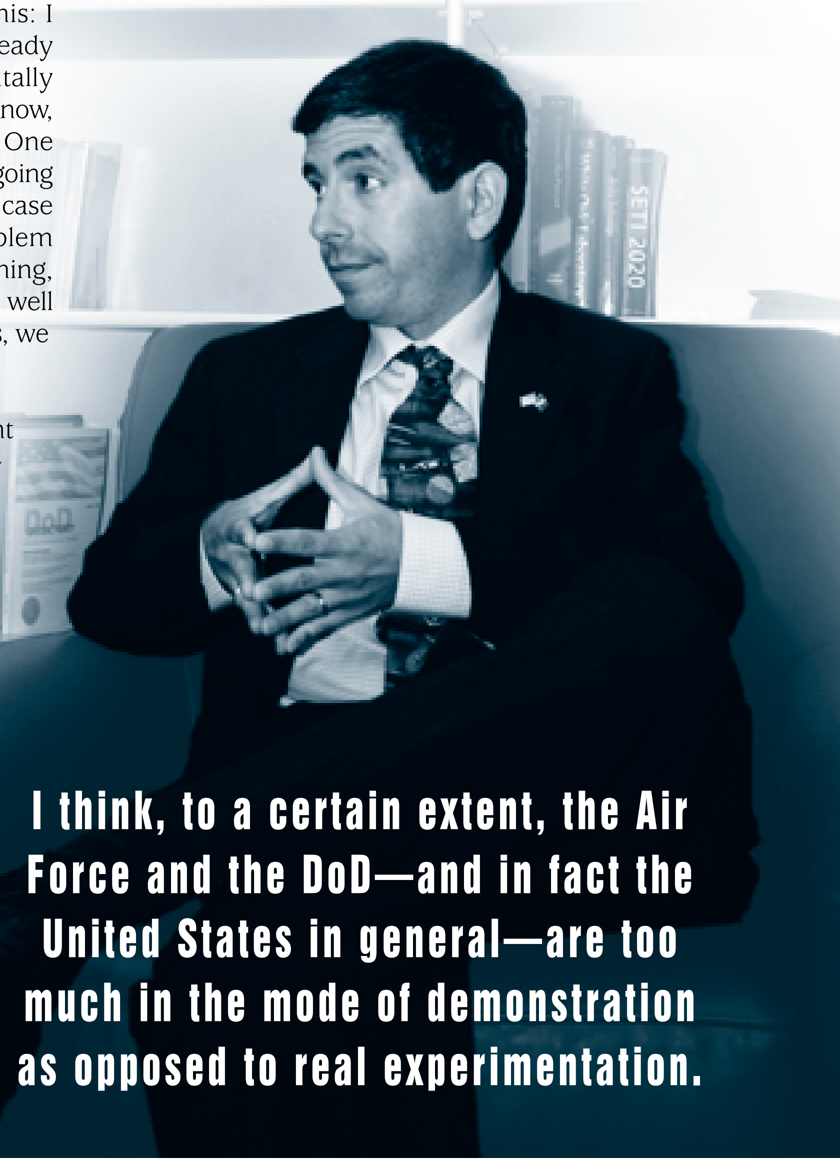
But the definition of a demonstration I mean is this: I want to prove to some skeptics something that I already know. In my way of thinking, that is a fundamentally flawed approach. If I'm proving something I already know, why am I doing it? There are a couple of outcomes. One is that it works, and then—so what? You knew it was going to work! The other is that it doesn't work, in which case you've just fallen flat on your face. The other problem with that notion is that if I am trying to prove something, that means I have a skeptic, which means I darned well better have that skeptic identified. But in most cases, we don't.

My argument is that we need to be taking a different approach: to go back to our roots, which is experimentation. In experimentation, I have a list of questions, perhaps some mysteries, puzzles, or issues, that I need to solve. I ask what experiments I need to do to find my answers. I don't assume the answer up front. I may have an idea what the answer should be, could be, or what I want it to be, but I do fair and honest experimentation; and whatever answer I get, that is the proper answer.

My model for that is the X-15 rocketplane program. The X-15 flew in the 1960s, pushing the boundaries of speed and altitude. It was a very successful joint Air Force, Navy, and NASA program. The X-15 had 199 flights, and every one was an experiment, not a demonstration. Some 750 technical documents came out of the X-15 flights.

This is the kind of model we need to be going towards, and once we do that, it reduces our risk up front. In other words, we learn *before* we are making the investment in the large, expensive system. There is another part to this philosophy, which is that we are willing to take risks. When you are doing an experiment, it's okay if that experiment doesn't work. I learn just as much sometimes from an experiment that doesn't work as from one that does work. But with a demonstration, if it doesn't work, then it fails. If we do the risk taking up front at the experiment stage, it really sets us up for program success down the line.

I'll give you my favorite example of this. Several months ago, I was supposed to see a wind tunnel test that the Air Force was sponsoring with a private sector company. A couple of days before the test, the lead engineer called, very embarrassed and apologetic, to say they wouldn't be able to show me the test because there had been a



I think, to a certain extent, the Air Force and the DoD—and in fact the United States in general—are too much in the mode of demonstration as opposed to real experimentation.

problem with the wind tunnel model—part of it had burned through at high speed. He asked me to please keep it all hush-hush. I said, "Wait, hold it right there. This is great news. You did exactly what you are supposed to do on the ground. We want to push our models to the absolute limit. We want to push them until we have burn-throughs and things fall off; that's why we do research and testing. Don't be embarrassed about what happened. You are to be congratulated. It was a job well done."

And I think that's the philosophy that we need to encourage in the Air Force, that we are willing to break things on the ground in smaller-scale tests, so that when we actually go to build the real article, we won't have those problems.

Q

*What do you see as the linkage between the S&T activities and the JCIDS [*Joint Capabilities Integration & Development System*] process, beginning with the acquisition process?*

A

Transitioning technology is, I think, one of the biggest challenges we face in the S&T world—how do we make sure our good ideas transition into capabilities? The under secretary has actually been developing a lot of ideas, often along the same lines as some of the ideas we were just talking about: taking the risk up front, having a smooth transition path.

An important element is linking the S&T people with the operational people, or as we like to say, linking them to the pointy end of the spear. It is easy, sometimes, for the folk in the lab to lose sight of the greater Air Force picture or application. What can really help that process along is keeping those connections going; making sure that the Air Combat Command, Space Command, and Air Mobility Command people are aware of what the lab is doing and what their capabilities are.

At the same time, we have to be careful we don't err too far on the side of providing short-term solutions. The easiest way to transition technology is to focus on the short term. I need something today. Can you give it to me now? And if you can, great; I've got my transition. But if you do that, then you lose the long-term investment, and we won't have the next revolutionary technology. It is important that as we look at this transitional strategy, we've got to have a balanced portfolio. You've got to have the short-term, rapid response; you've got to have the long-term, distant investment; and you've got to have everything in between.

Q

One of the stated goals of Air Force S&T is to encourage academia to pursue Air Force-relevant problems and prepare the next generation of scientists and engineers. What is being done to recruit new talent into the Air Force S&T workforce? How is the Air Force retaining in-house expertise?

A

This is obviously a topic that is near and dear to my heart. As a university professor on loan to the Air Force, one of the great things I see in the Air Force is the recognition of the importance of training the next generation and mentorship of the workforce.

The Air Force has done an outstanding job of reaching out to the academic community and supporting research and education in areas that are relevant. Obviously, our key player in that is the Office of Scientific Research, which I highlight as one of the crown jewels in the Air Force S&T portfolio. The Air Force Office of Scientific Research has ownership of our basic research, our 6.1 portfolio. [*6.1 refers to the program element for basic scientific research, the discovery of fundamental knowledge that doesn't necessarily have a systems application at the time of its discovery. Lasers, turbine engines, and carbon fibers are the result of basic research.*] They sponsor work within the other directorates in our Lab, but they also sponsor work at universities around the country. If you look at their portfolio, it is truly phenomenal. At any given time, they're sponsoring something in the order of about 1,000 different projects. Not only do they have the greatest minds in academia working on problems that are relevant to the Air Force, but at the same time (by the very nature of academia) they are doing research and creating references in fields that are important to us in the Air Force.

A number that I like to quote: the United States Air Force, through our Office of Scientific Research, is responsible in some part for producing approximately 15,000 technical doctoral degrees in the United States every decade. That is really quite an impressive number.

But our reach goes even further than that. There are some people who point out that we train people, but what happens, they ask, if those people don't go work for the Air Force. Well, would it be the worst thing in the universe if a graduate student decided, although he or she was hired by the Air Force Research Lab, to take a job in industry or go to work for the Navy or the Army? It is still a net win for the Air Force if at some point in their careers, they are contributing to the body of knowledge that will support the Air Force, wherever they wind up working.

My graduate education was actually paid for by the Navy. I was part of the Office of Naval Research Fellowship program. Over the years, I've done work for the Navy, but when I look at it, I think the Air Force got the better part of the deal—but I hope the Navy looks at it as a net win for the Department of Defense.

I can also point to other parts of the lab that are producing really amazing things for the next generation. Case in point is the Space Vehicle Directorate, which brings in students from around the country for several research projects. There's no better way to get students involved than to give them that co-op experience. They learn all the exciting stuff that we doing in the Air Force. We know we won't catch them all, but if we catch even a reasonable percentage of them, then we've done our job.

Q

And what's the Air Force doing to retain the existing expertise in the workforce?

A

I don't directly control the manpower issues, but obviously manpower is an element of S&T health for the Air Force. We need to have a competent in-house science and technology workforce. It's true for civilians and the military. I would argue that every person involved with these positions in the Air Force needs to have some technical competence as we acquire technical systems.

When a lieutenant, a captain, or a major is presented with the latest and greatest concept, that officer needs to be smart enough to say, "You know, this doesn't quite make sense," or "This won't work," or "This doesn't really do what we need to do."

Having said that, it isn't easy to do. I'm often asked by parents of students who are interested in pursuing aerospace engineering, "How much money will my child make when he or she becomes an aerospace engineer?" And I have a standard response: "If that's the first question you ask, this probably isn't the right field for your child." We don't become scientists and engineers because we are going to get rich; we do it because it is a really exciting and fun field. So what we need to do for our in-house people is to make sure that they have fun, exciting, meaningful things to work on.

When I look at the young people coming into our Air Force S&T enterprise, they are doing things, taking responsibility, and running programs far beyond what their peers would be doing in industry. They might not be paid as well, but the level of responsibility and authority, and their ability to go out and meet other people in their field far exceed that of most of their industrial counterparts. *That* is the point we need to make.

Q

*We've seen many examples of technology going straight to the warfighter. The Predator and Global Hawk UAVs [*Unmanned Aerial Vehicles*] are Air Force examples that weren't acquisition programs. What are the current initiatives to expedite technology to satisfy our urgent needs?*

A

We have a number. I am especially excited that the Air Force Research Lab has recently stood up a rapid response team. They call this one of their core processes. It is a small group that can be tapped into to assemble the right people from across the lab and across the Air Force, if

An important element is linking the S&T people with the operational people, or as we like to say, linking them to the pointy end of the spear. It is easy, sometimes, for the folk in the lab to lose sight of the greater Air Force picture or application.

necessary reaching outside the Air Force, when some critical issue arises so that the problem is addressed rapidly.

A very recent example: the problem of helicopter brownout. When helicopters land in a sandy, dirty environment, very often they kick up lots of dust, and it makes a very dangerous situation: Just when you need your last critical navigation waypoint, you get blinded by the material tossed-up.

The Special Operations people down in Florida asked for the Lab to look at this. A team was assembled, and they said, "Okay, let's look at this from multiple layers. First, what is the quickest way we can solve this problem—not necessarily the best way, but the quickest? There are a couple of things we could do. One would be to figure out how to *not* kick up the cloud of dust; the other might be how to come up with some sort of dust-penetrating radar that could see through the cloud of dust." So they looked at those options but then said, "Wait a minute—what we *really* need is to allow the helicopter to land, which may not mean looking through the cloud of dust; it could mean taking a snapshot before kicking up the cloud of dust, then using a computer algorithm that allows the pilot to land off that snapshot. If he's 100 feet up, the terrain isn't going to change an awful lot in the few seconds it takes to descend and land."

The first time they showed it to the warfighters, they loved it, and said, "Hey, if we've got the nifty camera to take that snapshot, there are a whole bunch of other things we could do with it as well." It shows you the kind of great synergies we get when we match the researchers to the operations folk.

Q

How do the particular needs and an unusual problem like that get recognized?

A

There are several ways. One is building those ties between our S&T people and the operational people. I travel around to different areas in the Air Force to ask the questions, "What can Air Force science and technology do for you? What are your most pressing needs?" As I get answers, I try to get those people connected to the right research people.

There are laboratory liaisons at the major commands, and the major commands have stepped up to it. For example, Air Combat Command signed on to the idea of setting up a chief scientist's office when they hired someone from the Lab to become their S&T lead. They hired Dr. Janet Fender [*as the scientific advisor for Air Combat Command*], who came out of the Space Vehicles Directorate, and she has done a marvelous job of providing that connectivity. Air Mobility Command has also just hired a chief scientist, Dr. Don Erbschloe, an outstanding pilot who was once a military assistant for one of my predecessors. The Air Force Space Command had a chief scientist, but they let the position lapse; they are now looking to rebuild it. Those connections are exactly what we need.

Q

How are the seven Air Force battlelabs instrumental in implementing near-term innovative solutions?

A

The very nature of the battlelabs and their raison d'être is to address the near-term solutions. I run into some folks in other parts of the S&T community who feel a little concerned about battlelabs; they want to make sure the battlelabs don't take away parts of the Air Force mission from the research labs. I look at it in a different way: One of the things I worry about most is that the research labs not lose the long-term focus. The battlelabs relieve some of that pressure, allowing the research labs to take on those long-term subjects. The battlelabs are addressing today's subjects and primarily dealing with off-the-shelf technology and very near-term and operations-driven matters. I think their mission fits in very well with the Air Force Research Lab.

Every six months, I chair the Chief Scientist's Group, where we get all the chief scientists of the various Lab directorates and major commands, and the scientific leadership from the battlelabs together in one location to get those connections going. That is one of the key elements of my job. Case in point: we've got good connections between the UAV battlelab and the Air Vehicles Directorate of the Air Force Research Lab. It's a natural marriage between organizations that don't have overlapping missions but have very closely related missions.

Q

While lifecycle issues are normally addressed in standard acquisition programs, it is sometimes necessary to incorporate such planning in urgent technology programs such as you've just described. How is that being addressed today at AFRL?

A

Technical lifecycle issues are among our most important issues. I keep reminding people that the age of our air fleet is approaching 25 years. That is older than any other major air fleet. Obviously, lifecycle issues are important now and will be increasingly important as our air fleet continues to age. We need to be addressing those on several fronts: not only maintaining what we've got, but also looking to the future. The systems that we are rolling out today may very well be flying 50, 60, 75 years into the future, so the lifecycle has to be embedded into the design process, into our implementation of the systems.

Now here is what makes things particularly challenging. As we introduce new technology, we introduce new lifecycle terms. Take composite airplane parts. Incredible technology. But what will the impact of composites be on the lifecycle of our air fleet? I think we are just beginning to understand some of those issues. We are just beginning to understand the implications for the maintaining, not just the designing of materials like composites.

It might get back to asking some very basic questions. For example, I visited one of our maintenance depots recently, and they showed me a beautiful facility they had just built for doing depainting of some of our newer aircraft. So one of the people from the Lab who was with me asked how often you have to depaint a composite airplane. That's a good question. Maybe you don't even have to depaint a composite airplane. Maybe if you put the color into the composite from the get-go, it would never have to be painted.

One thing I worry about as chief scientist is the tendency to latch onto the latest and greatest thing. My joke as a university science professor is that if you want to get a grant from some agencies, make sure your proposal uses the words "bio," "nano," "smart," "small" or "mimetic" in the title, and you'll get your funding! Of course, when new topics come up, we want to be clever enough or innovative enough to raise them, but we also have to remember that there are established disciplines in which we must maintain our expertise. One is sustaining our aging aircraft fleet.

Q

In addition to the current lifecycle challenges and issues, you must also keep an eye on the new technologies that will shape the future. In your opinion, what are some of the key technology drivers that will shape the next 20 years?

A

I have a few favorites. The Air Force portfolio is so large, and there are many exciting things going on across the board: in the cyberspace area and in the directed energy area, for example. My own research background is in hypersonic flight. To quote the previous chief of the British Air Staff, Sir Jock Stirrup—who is now their equivalent of our chairman of the Joint Chiefs—in modern air warfare, speed is the critical issue. I think hypersonics holds the potential for giving us that capability. If I can develop hypersonic technology for flying many times the speed of sound, I suddenly have an incredible weapon capability on my hands: a cruise missile that can cross a few hundred nautical miles in a very short time.

Eventually, hypersonic technology could open the path for a more accessible reach into space. A lot of us in the Pentagon are talking about making space a lot more operationally responsive, and there are some exciting technologies to make that happen. We're looking at stuff like smaller satellites, more responsive satellites, things we can build with plug-and-play approaches. The technology is in its infancy. Some people look at small satellites and

The young people coming into our Air Force S&T enterprise are doing things, taking responsibility, and running programs far beyond what their peers would be doing in industry.

say they will never completely replace the larger capability we have today, to which I say, "Yes, that's absolutely correct. They will not." But there are technologies that will allow us to build small things that can fly quickly. They might replenish lost capabilities or augment existing capabilities. We see avenues where the cost of flying a satellite might not be much more than some of our aerial missions today.

We learned a key lesson 10 years ago. NASA had adopted the mantra of "faster, cheaper, better," but we learned we can have only two out of the three. Some of the technology we are seeing in the lab today is showing us how we can do faster and cheaper. We agree that it won't be better—but that might be an advantageous trade-off.

Another critical issue in the Air Force, probably the area that has been occupying the greater part of my time in recent months, is the issue of fuel efficiency. The Air Force is the single biggest consumer of fuel in the U.S. government. Our fuel bill is huge, and it's even worse than you might suspect because if you start to factor in the fully burdened cost of fuel, it's not just the price of the gallon of fuel, but also the cost of the infrastructure necessary to get that gallon of fuel into, say, a tanker and out the boom into a fighter aircraft over the Pacific. You start doing those numbers and you quickly realize that anything you can do to reduce fuel consumption will provide a cascade of benefits to the Air Force.

How do you do that? Several ways. First, alternate fuels. They can reduce cost and our reliance on international sources. To that end, the Air Force has flown a B-52 bomber using a manufactured fuel called a Fisher-Tropsch fuel.

Second area: propulsion. I am fond of pointing out that it is hard to imagine any machine that could be more efficient than a modern jet engine. A typical jet engine has compressors that are 89 to 90 percent efficient, turbines that are 91 to 93 percent efficient. The jet engine is far more efficient than the human body. How can you do better than that? How do you use less fuel?

We have to step back and say, "If we can't improve component by component, let's improve the system." We are seeing focused technology questions across the Air Force, especially in the Lab, addressing how we improve the jet engine as a system.

Now one obvious point is that the jet engine is a point design. When I design an airplane, I pick a propulsion plant with one primary performance goal in mind. If it is for transport, I probably want range; if it is a fighter, I want some other measure of performance, probably thrust. If I go for range, I am not going to have a very good maneuver-performing type of airplane. If I go for high performance and speed, I'm not going to have really good range. Why couldn't I have an engine that could do *both* well through a variation in its operating cycle? This is the sort of exciting technology that I think can revolutionize propulsion.

Aeronautics is a key area. Can I build a more efficient airplane? I think the answer is yes. We know of technology and approaches that would get us away from standard tube-and-wing technology: flying-wing-based technologies, like a B-2 Bomber that could yield much more efficient airframes. Some simple technologies—putting winglets [*a vertical or angled extension at the tip of each wing*] on airplanes, for instance, might be something we could do that would improve the efficiency.

Now again, we've got to be careful. We don't want to jump on a bandwagon; like anything else, if you do things like winglets incorrectly, you cause more harm than good. But we've got some very smart people that are asking these questions, and it has some very serious interest in the operational Air Force.

Q

In August [2006], you completed a quarterly review of the Air Force Research Lab with Air Force Secretary Mike Wynne. Can you give us an overview of the current status of AFRL?

A

It was intended as a review of all the neat stuff going on in the lab. It touched on a number of topics, some of which were of specific interest to the secretary, such as work in the propulsion area and fuel efficiency issues. The Air Force has declared itself an air, space, and cyberspace force. That has some interesting implications Some people think that cyber is just communications or just intelligence gathering. It's not; cyberspace is a domain, just as air and space are domains. Part of the portfolio review touched on that and the leadership role that the AFRL is taking in the cyberspace domain.

Q

I hadn't heard that about the new version of the Air Force mission including cyberspace.

A

It is now part of our mission statement. It's an area where it is extremely important that we're working together with the other Services. Cyber is a very scary domain. I know of no other area where we are so susceptible to the proverbial asymmetric warfare. One of my big concerns is that we've become so dependant on space, and we're so far ahead of anyone else, that we are vulnerable if we are not careful. In the cyber area, one of the key things is to think both defensively and offensively and to make sure those two communities are engaged. The DoD cyber environ-

EDITOR-IN-CHIEF OF *DEFENSE AT&L* RETIRES

Collie J. Johnson, managing editor and most recently editor-in-chief of *Defense AT&L* and its predecessor publication, *Program Manager*, retires effective Jan. 3, 2007, after 37 years' federal civilian service. Johnson has managed the Defense Acquisition University's flagship publication since Oct. 1, 1994, and saw it evolve from a 24-page periodical to a 120-page bimonthly magazine.

Johnson began her government career in 1969 as a GS-3 benefits clerk in the Central Intelligence Agency, progressing over the years from personnel clerk and editorial assistant, to editor, managing editor, and GS-13 editor-in-chief. She has worked in three military departments—Army, Marine Corps, and Air Force—and her career also included 9 years of government service at Ramstein Air Base and Panzer Kaserne in the Federal Republic of Germany.

Johnson attended the University of Maryland (European Division), and Saint Leo's College, Fla., and went on to graduate in 1988 from the Defense Information School of Journalism. She received numerous awards and commendations over the years, including Vice President Gore's Hammer Award in 1996 for her communications outreach efforts in support of Department of Defense Acquisition Reform.

In retirement, Johnson plans to freelance as an editor, enjoy her four grandchildren, and travel stateside and overseas. She and her husband, John, will divide their time between homes in Covington, Va., and Sour Lake, Texas.

ment will be strongly influenced by the civilian environment. As an Air Force, we would never even think about protecting only Air Force assets and relinquishing our protection of civilian assets. If we worry about the airplane that some potential terrorist might fly into the World Trade Center, so should we be applying the same thought processes to the cyber infrastructure.

Q

There is an emphasis in the USAF to solicit an outside perspective to foster innovation and prevent technical inbreeding. You've stated that the key to successful innovation is a system of quality checks and mechanisms for bringing fresh ideas from outside the organization, for example from studies done by the Scientific Advisory Board. How are organizations outside the Air Force able to contribute ideas that are relevant and timely for your specific needs?

A

One of the many great and ingenious ideas of Hap Arnold was the understanding that in order to remain honest, you need to have an outside view. The very nature of my office is to have an outside perspective. But there is a catch to that: If you don't seek out the right outside advisors, or if you don't bring the advisors up to speed, then their points of view can become irrelevant. I think the Air Force does a phenomenal job in balancing the need for outside advice with the importance of bringing in people who understand what we do.

The Scientific Advisory Board is my best example of that. For a minimal investment (it is embarrassing, actually, how little we invest in the Scientific Advisory Board!), we get 50 of the most brilliant scientific minds in America. We bring them in, we teach them what the Air Force does, they learn what some of the acronyms mean and a little about Air Force programs—but we make sure they never lose that outsider's perspective.

There are other sources that we rely on, of course. For example, Rand Corporation does studies for the Air Force. There's even a National Academy board, the Air Force Studies Board, that serves a slightly different role, as they report directly to Congress. The interesting thing about the SAB is it reports directly to the chief and the secretary of the Air Force. It provides them a sounding board.

If you look across the range of government advisory boards, some that started as technical boards have crossed more into the policy issues. One of the great successes of the SAB is that we've managed to resist that.

I'll also brag about the fact that when I look at the many advisory boards I've served on, I know of none that has had a bigger impact on its parent organization than the Scientific Advisory Board. No other board's studies are read as thoroughly as our SAB studies.

Q

There is a desire to leverage testing and evaluation and S&T so that they work hand in hand, for example by sharing testing facilities. How is this a shift from the roles they've traditionally held?

A

The reality is that on some occasions, the T&E community was at odds with the S&T community. I think there was an erroneous impression that there was competition for resources. In recent years, thanks to smart leadership, we've almost erased that notion. There is a very strong effort now that links researchers directly with the testing and evaluation people.

At times, T&E folks can be a tremendous resource for S&T. If you're calibrating a wind tunnel, why not calibrate it with a model that is actually going to teach you something? One of the successes I can point to, one of our most prized test assets in the Air Force, is the Hypervelocity Wind Tunnel 9. It's a hypersonic wind tunnel that can simulate flight speeds up to around 16 times the speed of sound. The Tunnel 9 leadership has been pioneering the idea of bringing in university people. They've got students running all around the wind tunnel, working on undergraduate and graduate projects that have direct input to tests in the tunnel. Students are being educated, they are building the technology—and oh, by the way, it is a net win for the T&E and S&T communities.

This also means we need to be doing our planning in acquisition with both the S&T and T&E communities in mind. I mentioned that hypersonics is one of my favorite areas. But I can't just think about how I will experiment with that technology; I also have to think about how I will test it as it becomes available. That means ground test facilities, possibly flight test facilities. All those people have to be talking together; and the good news is, they are.

My third month in this office, in November of 2004, I went to the first Air Force Testing and Evaluation conference in California. It was a group of people from the Air Force Flight Test Center at Edwards Air Force Base and a group from the Arnold Engineering Development Center talking to each other. No one else. By my count, there were exactly two of what I call science and technology papers presented there. Fast forward to one year later: The next time they had that meeting, they had so many science and technology people attending, it was a joy to behold. And I see more T&E folks at our basic research meetings now. That dialogue is under way.

Q

I'd like to end by asking you about the X-vehicles; that is, aircraft and vehicles designed for experimental purposes to provide the Air Force a way to do research from the sky. Since 1995, 16 X-designations have been made, and more are expected. It has been said that X-vehicles can reduce acquisition risk up front. Can you talk more about X-vehicles, their potential for the Air Force, and how they figure into the procurement process?

A

The notion of X-vehicles, if properly executed, truly embodies what we discussed earlier: the idea of doing experimentation, not demonstration, and having a list of questions we want answered, instead of things that we are trying to prove at the starting gate.

A couple of examples come immediately to mind. We have a program that used to be called the Scramjet Engine Demo and is now the X-51, which will be a high-speed X-vehicle platform. The Air Force Research Lab, working with NASA, just got an Active Aeroelastic wing-vehicle designated the X-53, embodying that notion of the X-vehicle, where we take our risks and try our technologies. Aeroelasticity is the study of how air interacts with an aircraft structure; for instance, preventing an airplane wing from fluttering or breaking off. But this X-53 program is actually looking at how we can use active control of the structure to use the fluid/structure coupling and engineer the aircraft performance. It's the perfect thing to test with an X-vehicle—you wouldn't want to implement this on an operational system until you see if it works and learn more about it.

One of the things I've been encouraging in the Air Force is the X-vehicle concept. And by the way, we are using X-vehicles not just in our atmosphere; their use also extends into space. We've got a series of small satellite experiments called TacSat with other DoD partners, and I view TacSat as being the X-satellite. TacSat is not a delivered production capability. I don't look at it and say, "Okay, that works. Let's build more." Instead, it is an experimental platform where I can try the technology and see if it fits into our area of operations. Just because you have technology doesn't mean it is useful. X-vehicles allow us to try out how that technology works before we make a final decision.

Q

Dr. Lewis, thank you for being so generous with your time and for sharing your insights. Is there anything you'd like to add?

A

I've had two chiefs of staff now tell me that I have the best job in the Air Force. I agree with them. I get to tell the chief of the Air Force, "I am interested in this or that; I think this or that is important." And then I get the go-ahead: "Look into it for me." It is an amazing opportunity.