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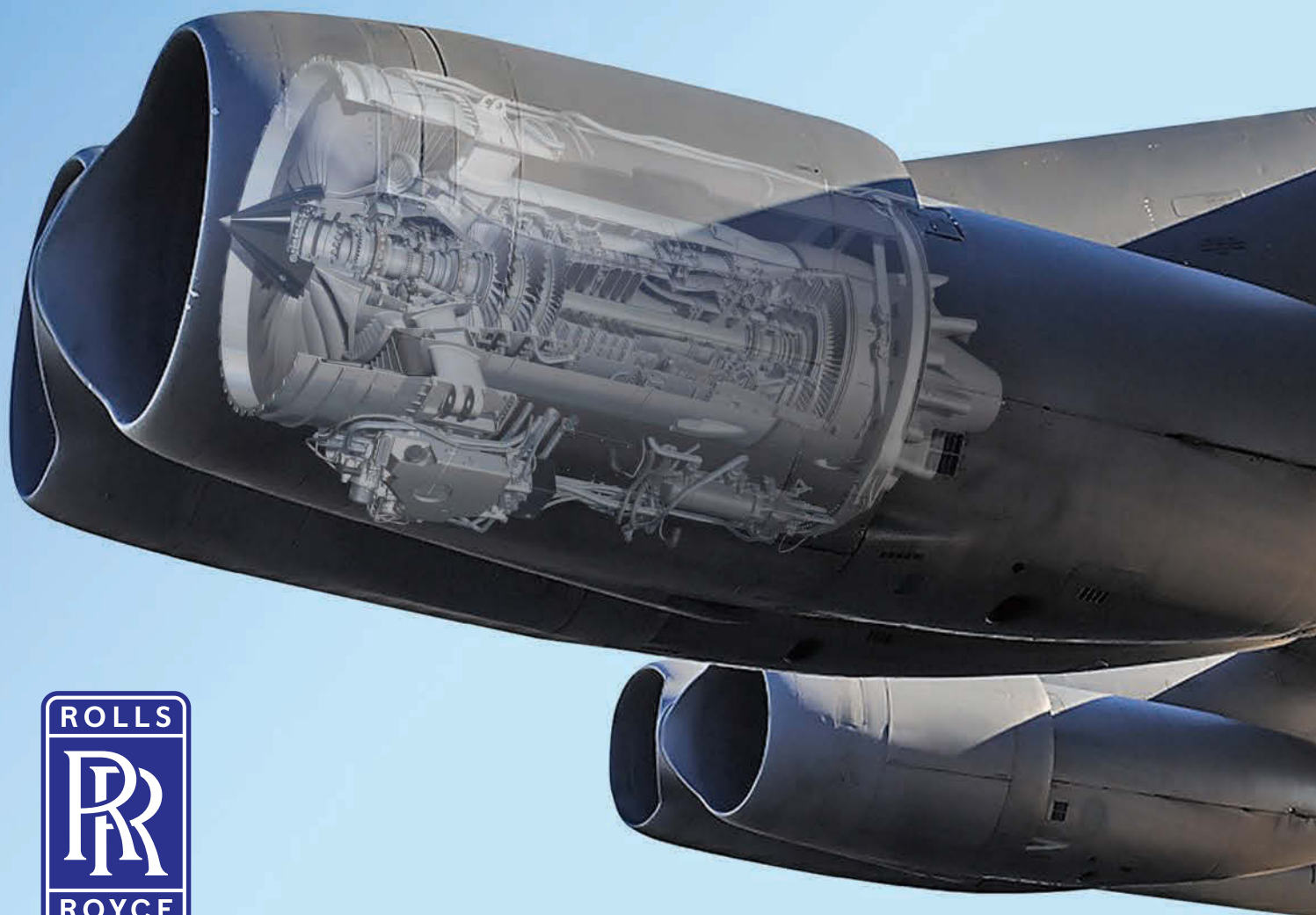
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Production Manager
Eric Chang Lee
Photo Editor
Mike Tsukamoto

Contributors
John T. Correll,
David A. Deptula,
Robert S. Dudney,
Robert Haddick
Jennifer Hlad,
William LaPlante

ADVERTISING:
Kirk Brown
Media Network Director
703.247.5829
kbrown@afa.org

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Photo illustration: Strategic Capabilities Office, Mike Tsukamoto

Fighter Math

Today's Air Force has too few squadrons, people, and planes to meet the requirements demanded by our National Defense Strategy, and the Pentagon's 2020 budget request doesn't do enough to address the shortfall.

The Air Force we have has 312 operational squadrons. "The Air Force We Need," as defined by Air Force Secretary Heather Wilson last fall, should have 386 squadrons, a force built to match the demands of a strategy that anticipates great power competition and, potentially, great power conflict in the future.

The Air Force has yet to share all the math behind that assertion, but it has laid out some details and more can be surmised. Consider, for example, the fighter force.

At the dawn of the current fiscal year, the Air Force possessed 2,073 fighters organized into 55 operational squadrons. Those planes average nearly 27 years of age—old and getting older. At the present pace of fighter acquisition—56 planes per year in the 2019 budget and the 2020 request—the fighter fleet will surpass 35 years of age, on average, in less than 10 years.

That's not a force built to deter a peer competitor, let alone win a major war.

The Air Force We Need requires 62 operational fighter squadrons. At 24 jets per squadron, plus jets for test and development, training, and spares, that works out to a requirement for 2,232 fighters.

$$(62 \text{ squadrons} \times 24 \text{ fighters}) \times 1.5 = 2,232$$

To sustain that force, the Air Force must buy 72 fighters per year. Doing so would ensure the average age of the fleet declines to 15.5 years and that all jets are retired after 31 years of service—which is still too old, but better than the current path the Air Force is on. This is not rocket science:

$$2,232 \text{ fighters} \div 72 \text{ jets} = 31 \text{ years service life}$$

Now look at the 2020 budget request. The Air Force is asking for 48 F-35As, down eight from the 56 approved by Congress for 2019. In their place, the budget request includes \$1.1 billion to buy the first eight of a planned 144 F-15EX aircraft, which would be purchased over the next 12 years. Here's what happens when you buy 56 planes a year and try to fulfill a requirement for 2,232 jets:

$$2,232 \text{ fighters} \div 56 \text{ jets} = 39.85 \text{ years service life}$$

The reason this is a hot topic today is that current F-15Cs will be 44 years old in 2030. They can't make it that long. But buying the F-15EX—a "new, old airplane"—is hardly the solution. That's a 30-year fix to a 10-year problem. The wiser course is to buy more F-35s more quickly. Instead of a short-term solution that presents a new long-term liability, accelerating the shift to 5th generation aircraft improves the long-term outlook for the fighter fleet.

The alternative is not viable. Do we really want to rush into an age of great power competition buying airframes conceived 50 years ago that will stay in our inventory for the next 40 years? That's like fighting the air war over Bosnia with the Wright Flyer. That air war was hard enough on then-state-of-the-art F-16s. We even lost an F-117 stealth jet. Whose sons and daughters are we dooming to such a fate?

China and Russia continue to advance their anti-aircraft defenses. They are developing long-range, hypersonic missiles designed to threaten US aircraft carriers and push them father and farther away from China's shores. In time, they will sell those capabilities to allies, undermining US air superiority around the world. To counter and deter Chinese aggression, the US needs the kind of deep penetrating capability that only comes with low-observable technology.

Critics will counter that stealth is expensive and the cost of operating low-observable aircraft remains too high. That's only true if you look at airplanes as one-for-one replacements. In reality, stealth reduces the number of aircraft needed to accomplish the same mission.

$$1 \text{ F-35A} \neq 1 \text{ F-15EX}$$

When one plane can do the job of six or eight or 12—depending on the mission—the cost per desired effect declines precipitously. That single plane, pilot, and maintainer crew will never be as costly as the dozen legacy aircraft and all the people needed to support them.

Air Force Chief of Staff David L. Goldfein knows too well the cost of flying into a sophisticated air defense system. His 4th gen F-16 was shot down over Serbia in 1999. He celebrates his rescue annually.

Would he want to fly similar technology into the teeth of a modern Chinese air defense system today? How about 20 years from now? How about 40?

Here's his answer: "In a perfect world, where we'd have the resources available to us, the 72 fighters a year would be F-35s, because an F-15, or any variant, will never be an F-35."

Indeed, buying more F-15s was not the Air Force's idea. Secretary Wilson made that clear Feb. 28: "Our budget proposal that we initially submitted did not include additional 4th generation aircraft."


Then-Defense Secretary Jim Mattis made that call, having decided the Air Force needed an alternative source of fighters to counter Lockheed's position as the sole supplier of 5th generation fighters.

Mattis was a fine Marine general, a great leader, and steward as Secretary, but this decision missed the mark. It doesn't even make economic sense. The F-15EX will cost no less to acquire than the F-35A, which Lockheed says will cost \$80 million a copy by 2020. With increasing production, it should grow less expensive. By contrast, F-15s are selling for closer to \$100 million each and building just a dozen a year reflects far smaller economies of scale.

More importantly, if America has to go to war against China in the next 40 years, this plane must be left at home. Our Air Force needs planes it can take to the fight now, and for decades to come. It needs planes that adversaries find sufficiently threatening to deter them from provoking a US response.

The difference between the Air Force "we have" and the Air Force "we need" boils down to this: The Air Force needs 72 new fighters a year to sustain a lethal, fighting force. Until something better is developed, the F-35 is the best plane for the money. Expressed mathematically, we can say unequivocally:

$$\text{F-35} > \text{F-15EX}$$

Fortunately, the Pentagon does not get the final word. Congress has a chance to do the right thing: Say, "no" to F-15EX. Say, "yes" to more F-35s. 



Letter From the President

Join the Fight

It is the honor of a lifetime to follow Gen. Larry Spencer as your new AFA President. General Spencer has done a tremendous job leading our Air Force Association over the past three-and-a-half years. So also has our board, and its chairman, former Air Force Secretary Whit Peters.



Photo: Mike Tsukamoto/staff

Lt. Gen. Bruce Wright, AFA President

Our world today is flush with opportunity, but our nation and our Air Force face real and serious threats. The United States is in a fierce competition of ideas and preeminence on the world stage. Multiple world leaders are openly and aggressively seeking to replace American leadership that encourages freedom for all with extreme agendas that hinge on oppressive economic, technological, and military dominance.

At this year's Air Warfare Symposium, we heard repeatedly from Air Force leadership about the real threats posed by China and Russia, the ongoing turmoil caused by regimes in Iran and North Korea, and the constant danger of violent extremism around the globe. The worldwide challenges to our nation are daunting, and it will take the courage of

all of us to prevail against them.

In the United States of America, there is always hope, and our newest generation of leaders is inspiring. I recently participated in the National Character and Leadership Symposium held annually at our US Air Force Academy. Our leaders of the future are men and women of character with a work ethic founded on freedom and opportunity. They believe in our nation and our values. They will not fail, and we will be with them.

The Air Force has been at war for more than two decades and remains engaged in demanding combat operations. Today, as global threats increase, the Air Force is too small and its weapons are too old to meet all that is required of it. Air Force leadership is out there making that case, and our airmen are risking their lives every hour. They need our support and they should never be alone.

The mission of our US Air Force is to fly, fight, and win in air, space, and cyberspace. Our nation, our airmen and their families, our veterans, younger current and future leaders, and our wounded need their Air Force Association as much or more than any time in our history. Please join the fight.

Lt. Gen. (Ret.) Bruce "Orville" Wright
President
Air Force Association

Air Force Association

1501 Lee Highway • Arlington, VA 22209-1198

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Telephone: **703.247.5800**

Toll-free: **800.727.3337**

Fax: **703.247.5853**

AFA's Mission

Our mission is to promote a dominant United States Air Force and a strong national defense and to honor airmen and our Air Force heritage.

To accomplish this, we:

- **Educate** the public on the critical need for unmatched aerospace power and a technically superior workforce to ensure US national security.
- **Advocate** for aerospace power and STEM education.
- **Support** the Total Air Force family and promote aerospace education.

Contacts

CyberPatriot info@uscypatriot.org
Field Services field@afa.org
Government Relations grl@afa.org
Insurance afa.service@mercercor.com
Membership membership@afa.org
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Sharp-Eyed Readers

The March issue's "Namesakes" (p. 64) identifies an aerial photo of Bolling Field in 1924, and shows several aircraft that look suspiciously like two C-47's, six B-17's, and maybe a B-25. In 1924? Must have been very early models.

Maj. Paul Rodriguez,
USAF (Ret.)
Kansas City, Mo.

On p. 41 of your March issue, it is stated that the motto of the 65th SOS (Scientia Fortuna Iuvat) translates to "fortune favors the bold."

However, Scientia means "knowledge" in Latin. Rather, audaces would be the correct word for "bold" or "brave." So, I'm thinking the motto translates more like "fortune favors the knowing." And, as a professor, I do like that translation better.

Lt. Col. Joe Bassi,
USAF (Ret.)
El Paso, Texas

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WRITE TO US

Do you have a comment about a current article in the magazine? Write to "Letters," *Air Force Magazine*, 1501 Lee Highway, Arlington, VA 22209-1198 or email us at letters@afa.org. Letters should be concise and timely. We cannot acknowledge receipt of letters. We reserve the right to condense letters. Letters without name and city/base and state are not acceptable. Photographs cannot be used or returned.

—The Editors

Road Map for Vets

"We owe it to [our veterans] to ensure they are not forgotten upon their return home. They may have returned from the battlefield, but their war is not over. For many, their true battle begins when their purpose in the military ends."

Sarah Verardo, chief executive officer of The Independence Fund, a veteran's advocacy group, in a statement supporting

PREVENTS, the President's Road Map to Empower Veterans and End a National Tragedy of Suicide signed March 5.

CRACKS IN THE FOUNDATION



"Current internal tensions expose cracks in the Air Force that affect its ability to compete as a unified service ... on current roles and missions. Short of a decision about how to unify the service's culture, the Air Force risks becoming a 'conglomerate of activities.'"

Movement and Maneuver: Culture and the Competition Among the US Military Services, RAND report [February 2019].

FORECAST: Cloudy



Photo: DOD

"The Department has never built or implemented an enterprise cloud solution and therefore recognizes the importance of finding a commercial partner to help begin the process. ... The magnitude of effort required to stand up a General Purpose cloud at the scale and complexity of the Department is initially best served through a single provider that will allow DOD to maximize pace and minimize risk."

DOD Cloud Strategy, December 2018.



Photo: Mike Tsukamoto/staff

TEAMWORK

"In hypersonics, the Army had developed a warhead through DARPA that worked better than ours, but our booster worked better than the Navy's. So, we're putting the Army's warhead on our booster and testing it on ground, ship, and B-52 bomber platforms. ... Accelerating our nation's first operational boost-glide weapon five years earlier than anticipated."

Air Force Secretary Heather Wilson on prototyping and speeding up acquisition in a speech at AFA's Air Warfare Symposium, Feb. 28.

Cold Hotspots



Photo: Lance Cpl. Rachel Young-Porter/USMC

"If you were to draw a line from here to the DMZ between North and South Korea, both of these sites are on the 38th parallel. And so, the weather here accurately replicates the weather that we would encounter in North and South Korea."

Col. Kevin Hutchison, commander at the Marine Mountain Warfare Training Center in California, nearly 8,000 feet up in chest-high snow referring to preparation for the future great power competition [Associated Press, Feb. 20].

10-to-1 Odds

"I would like to bring the term 'cost imposition' into normal parlance in the Air Force. That was one of the mission objectives of my prior job: winning wars, but



Photo: Mike Tsukamoto/staff

disrupting adversaries through cost imposition. Cost imposition is simply doing a trade of resources spent to develop versus resources countering defeat. ... You're looking for a disproportionate return. I tended to like a 10-to-1 exchange on money—I can spend one increment, and it takes 10 to beat it. That's a good investment. When I look back at the early Air Force pushing airplanes all the time—supersonic, vertical take-off and landing stuff—every one of those now has a burden of time and money to counter. And in the end, the Cold War was won by winning a spending war."

William Roper, Air Force acquisition chief, in a March 1 interview with *Air Force Magazine*.

Never Give Up

"I am hopeful, although I have no commitment yet, that we will be back at it, that I'll have a team in Pyongyang in the next couple weeks. ... I'm continuing to work to find those places where there's a shared interest."

Secretary of State **Mike Pompeo's** remarks to the Iowa Farm Bureau on President Donald Trump and North Korea's President Kim Jong Un's denuclearization talks, March 4.

Ready or Not

"Airmen who have been nondeployable for more than a year will be notified by their chain of command and evaluated for either a referral to the Disability Evaluation System, consideration for administrative separation, or a retention determination."

Feb. 19, 2019, memo, signed by Assistant Secretary of the Air Force for Manpower and Reserve Affairs **Shon Manasco** regarding the Air Force's new retention policy.



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An F-16, F-35, and F-22 fly in formation during the Heritage Flight Course at Davis-Monthan AFB, Ariz., on March 2. The course prepares demonstration team pilots for the upcoming air show season.



Photo: SSgt. Jensen Stridham

An airman with the 352nd Special Operations Wing watches a CV-22 Osprey from the ramp of a MC-130J Commando II refueler. The wing performed the flyover to honor 10 US airmen who died when they deliberately crash-landed their B-17 to avoid killing residents and children near Endcliffe Park, UK, during World War II.



Photo: A1C Jennifer Zima



A B-1B Lancer flies in formation with a Qatari Mirage 2000 in February. The aircraft were participating with regional partners to test objective-based command and control actions during Joint Air Defense Exercise 19-01.



Photo: Ssgt. Clayton Cuptit

The Vice Chief's Challenge

The Vice Chief of Staff of the Air Force, Gen. Stephen W. "Seve" Wilson, met with Air Force Magazine editors Tobias Naegele and John Tirpak at AFA's Air Warfare Symposium in Orlando, Fla., to discuss the restoration of Tyndall AFB, Fla., artificial intelligence, innovation, emerging technology, and critical issues facing the force—from base capacity to the pilot shortage.

Q. The destruction of Tyndall AFB, Fla., by Hurricane Michael last fall gives you an opportunity to rebuild it as a "base of the future." What's your plan?

A. It presents us with a great opportunity. ... We have a five-year plan to get that back to where it needs to be. We think it's in the neighborhood of \$4.5-\$5 billion to fix it. ... And as we have to rebuild most of that infrastructure, it'll give us the opportunity to start fresh. ... We could put our first 5G network in, designed to the right standards so that any future storms don't cause impacts like that. ... We've got to get the right facilities in place and then look at how we scale that across the rest of the Air Force.

Q. A few years ago, the Air Force did a study that found it had more than 30 percent overcapacity in bases. It requested Base Realignment and Closure (BRAC) authorities to close or reduce some of them. Where does the Air Force stand now on its base structure?

A. I think the word we focus on more is 'realignment,' and [whether] we have the infrastructure aligned as it best can be, and optimized for the missions we have.

I was one of those guys who went to the Senate and the House and talked about the 30 percent capacity overage that we thought we had. And, ... they challenged me on the numbers. ... If we're going to live in a fixed-budget world ... we can't have ... all this infrastructure that we can't afford and can't pay for.

Q. Does that mean there's still some structure you need to shed?

A. I think we need to look at all the data. ... I can show you that, over time, with the *wrong* investments, that I'll have my whole infrastructure 'red' in the next 20 years ... [meaning] beyond life expectancy, with severe, critical problems. Or, with the *right* investments, how I can green it up.

Q. When do you think you'll have a sense of the right path forward?

A. I think we're still a few months away.

Q. You've been grappling with a pilot shortage, just as the other services and the airlines have. And you've put in measures to try to retain pilots and recruit more. But are there ways to reduce the need for pilots, by shifting to more unmanned systems?

A. Probably both. I think our largest fleet today is MQ-9s. ...

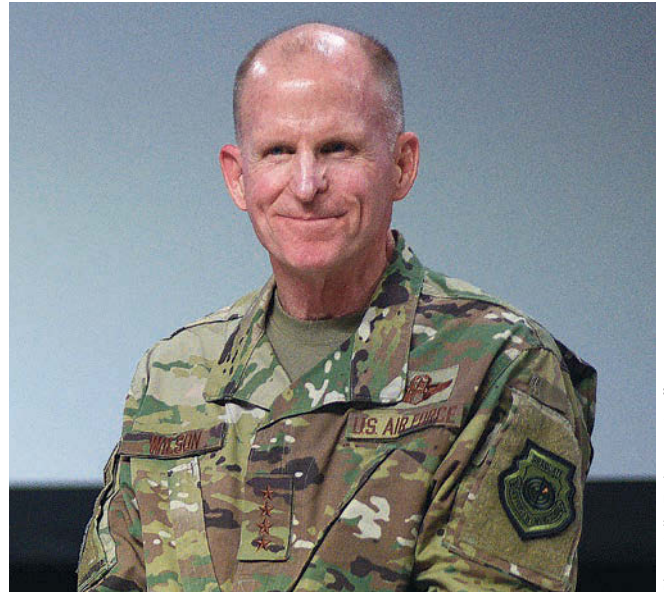


Photo: Mike Tsukamoto/staff

Gen. Stephen "Seve" Wilson also appeared on the Future Force Faster panel at Air Force Association's Air Warfare Symposium in Orlando, Fla., held Feb. 27-March 1.

Q. But they still have a remote pilot.

A. That's a great point. [Lt. Gen. Steven L.] Kwast and his team at AETC are doing some fabulous work on Pilot Training Next. We've ramped up our production ... it's not insignificant to go from about a thousand pilots a year ... in '16 to 1,500 pilots a year in '20. ... That's a big, big jump in pilots. Some of ... their initial work ... with Pilot Training Next showed huge potential savings in time on how we do it. Students were able to learn and be as good in 30 percent to 50 percent shorter times. So we'll see how that plays out.

That scales, not just across pilots, [but] when you marry that to maintainers and maintainer NEXT, you can use augmented reality headsets to be able to speed up the training. Now I'm looking at what I'm doing. It gives me a little visual insight. So the potential with that is huge.

And then we have to work hard on the retention piece: the quality of life for the families. They've got to look at our Air Force and what we are doing as an employer of choice, versus [private industry]. Right now, when you ask lots of them why they're leaving, they'd say, "ops tempo." It's not uncommon to find a captain [who's already completed] six six-month deployments [all] as a captain, right? So, his family looks at that and says, "If I don't see an end to that, then ..." I look back on my time as a captain, I loved my squadron. I loved the folks who were in it. We vacationed together. We visited great places. I didn't want to go do something else, because I liked the people I was doing it with, I liked the mission I was doing. But I didn't have an ops tempo that said, "Six months gone, a year at home. Six months gone, a year at home." We've got to get that right balance back.

Q. So how do you solve this problem if your operating tempo doesn't change?

A. We look toward, 'How do we posture for the future? What is a dynamic force presence?' So, do I always have to be there? Or can I be there when I need to be there, and we set the conditions and the time, versus cyclical rotations.

As we look toward what great power competition is really going to entail ... we are too small for what our nation needs. And the Air Force we need is about 25 percent bigger than the Air Force we have. ... That's part of what we're trying to tell Congress. Certainly, it may be more people to start with, but it's also more stuff. ... We're not capitalizing the force on the timeline we need. We need to be able to [buy] 72 [fighter] airplanes a year to drive the age of the force down. All of this is intertwined between the pilots and the equipment. We're too small for what our nation needs.

Where the majority of pilots are short [is not in flying jobs but] ... on staff. ... The risk we're taking is really on the staffs and the lack of expertise [needed in those jobs] ...

Q. Then-Defense Secretary Mattis gave the Air Force a year to get the mission capable rates of the F-16, F-22, and F-35 up to 80 percent. Will you make it, or will you need some waivers?

A. Right now, in general, we're on track across the three systems to do that. Maybe the hardest is the F-22 just because of what they went through at Tyndall. We redistributed the planes and had to get the [low-observable technology] back up ... the F-22 is probably the most challenging one of those. We're focused on how do we shift the money to get the right weapons system support with the right parts and the right manning. ...

We track it by month. Right now we're on track.

Q. The 'Air Force We Need' construct says you want to add seven bomber squadrons to help deal with adversaries at long range. But plans say the Air Force will stick at 175 bombers: About 100 B-21s and the 75 B-52s we already have. So where do you get more squadrons?

A. We're short on bomber squadrons. We do think that in the high-end fight against a peer adversary, that our bombers are going to be really important, because of what bombers bring to the fight with range, capacity ... both stand-in and standoff. ...

We're going to have to look at what a standard bomber squadron is. Today, it's ... 12 [aircraft]. You kind of alluded to whether they're combat-coded. ... We still have some work to do, I would say ... on the analysis behind the bomber force structure to get to your answer.

B-52s have been an amazing workhorse, but as we bring on the B-21, we've said we need a minimum of 100 of those. ...

I had to testify to the Senate Armed Services Committee ... about the B-21, and I told them—it's on track, on schedule, on budget. Gen. Timothy Ray [commander at Global Strike Command] wants to make sure they've looked through all the different timing and options for the bomber force going forward, so I think there are discussions with the Secretary on that.

Q. What are you doing to infuse a culture of innovation among airmen?

A. I've used the analogies of Ty Cobb and Babe Ruth. I need my squadrons every day being Ty Cobb, hitting those singles, looking around the squadron and saying, 'How do I incrementally make us better every day?' ... Then there's the

Babe Ruth analogy. Babe Ruth was known for two things: home runs and strikeouts. I'm okay with both. I swung and I missed, but I took a big swing, all right? But what are those things that are going to change fundamentally how we do business and the way we think through problems? Our research lab looks at lots of things to [determine]: Where are we leading? Where are we tracking?

Q. Tell us about the next Vice Chief Challenge.

A. In the past, we've always done 'bottom-up.' We say, 'Airmen, give us your ideas.' This time, we did it a bit differently. ... Let's also go top-down. I'll give you one of my hardest problems: How do I really do multi-domain operations, and how do I command and control that across all domains?

One of the analogies I use is the 'Waze' app on your phone. It's crowd-sourced with traffic information ... it will reroute you, real-time, around an accident. And it doesn't optimize it for time, it optimizes it for traffic flow. ... You've taken a one-minute longer road, but it's flowing the traffic so everyone doesn't congest on the shortest [route]. If I can do that on the ground, why can't I do that in the air? Why isn't there a Waze-like app that shows me air traffic, that optimizes for conditions like thunderstorms, traffic routings? ... Why can't I do that for space? And if I can do it for those, how can I pull those together and have a common operating picture between air, space, cyber across the board?

So that's the Vice Chief Challenge. I want your ideas. We've had over 300. We've now down-selected to 20 ... that we think are the best ideas. We're going to bring in academia, industry, make further down-selects, and at AFA [Air, Space & Cyber Conference] in September, we're going to showcase our front-line ones.

Q. Why is this such an imperative?

A. President Xi [Jinping of China] has said he wants China to be the world leader in AI by 2030. China and Russia are modernizing their forces, investing for the long haul, in mega-projects. And they are driving in a whole-of-government way to meet those marks. So, that's the 'why.' We, the American people, need to be clear-eyed with what's going on around the world in this great power competition.

Q. So, it's a 'Sputnik Moment?'

A. Right. ... We went from behind [regarding] Sputnik, from President Kennedy on May 25, 1961, saying we're gonna go to the moon and back, and we as a nation went all in, right? And it wasn't the military. It was NASA. It was industry. It was academia. We went all in, and in eight years, we had 36 launches across the Mercury, Gemini, and Apollo programs. We built things. We have to realize, again, we are back in competition. And then I tell people, ... the 'why,' the 'what,' and the 'who.' The 'who' becomes us—all of us—average ordinary American citizens. ... Airmen, who look at it and say, 'I can make this better. I can make a difference.' It's going to take all of us.

Q. But, if the Chinese are producing eight times the STEM graduates of the United States, how do we catch up?

A. We do it differently. Our values are different. The way that we empower our people is different. ... Their centralized control of everything is different. What's going to allow us to win is our innovation and our people, [who] are empowered because of the society that we live in, to go do it. ❏

By John A. Tirpak

F-15EX: Careful What You Don't Ask For

Two advanced F-15s show off heavy weapons loads in this Boeing concept image.



Screenshot: Boeing video

While it was an open secret for months that the Air Force's fiscal year 2020 budget request would include some brand-new F-15s, one of the surprise revelations at AFA's 2019 Air Warfare Symposium was that those new Eagles weren't the Air Force's idea.

Air Force Secretary Heather Wilson, at a Feb. 28 press conference, admitted that while new "F-15EXs" are in the budget—later revealed to be eight airplanes for \$1.1 billion, as a down payment on an eventual 144 aircraft—someone else at DOD inserted them in USAF's budget to help the service address its inadequate fighter force structure.

"Our budget proposal that we initially submitted ... did not include additional fourth-generation aircraft," she acknowledged.

Washington wags initially suggested the F-15 was injected into the Air Force budget by Acting Defense Secretary Patrick Shanahan, who had a 30-year career with Boeing, maker of the F-15. Shanahan has recused himself from matters involving Boeing, however, and dismissed the idea that he is shilling for the company as "just noise." Nevertheless, Boeing has received a disproportionate share of major defense contracts in the last six months, including the T-X trainer, UH-1N helicopter replacement program, and the MQ-25 Navy aerial tanker drone.

At the rollout of the 2020 defense budget request, however, Pentagon Comptroller Elaine A. McCusker revealed that it was former Defense Secretary Jim Mattis who ordered the Air Force to buy new Eagles.

Creating a "balance between the fourth and fifth-generation aircraft... [was] a decision that was made by Secretary Mattis before he left," she said, noting that he had paid a lot of

attention to "our cost calculus" in the field of tactical aviation.

Gen. Joseph F. Dunford Jr., Chairman of the Joint Chiefs of Staff, told members of the Senate Armed Services Committee a few days later the "framework" for the decision came from a study of the future needs of the military's tactical aircraft fleet, which showed the Air Force has a shortage in its number of aircraft and the amount of ordnance those aircraft could carry. When combined with the fact the F-15C will age out in the 2027-28 time frame, Dunford said "the best solution" was to go with the F-15EX to "backfill" the F-15 fleet.

The EX-variant initially would only be "slightly" cheaper to buy than a new F-35, but it will be more than 50 percent cheaper than the Joint Strike Fighter to operate over its life, Dunford said.

More of the calculus was explained by Maj. Gen. David A. Krumm, USAF's Director of Strategic Plans and Requirements, who told *Air Force Magazine* the thinking behind the controversial add of Eagles. Essentially, he said, the National Defense Strategy demands more combat capacity immediately, or as soon as possible. And while buying more F-35s is the Air Force's preferred solution, the F-15EX move could put more iron on the ramp more quickly; mostly because the transition time for individual units would take months rather than years.

"Cost of ownership," is the key factor in the F-15EX's favor, Krumm said.

"There's 80-90 percent commonality" between the F-15C and the F-15EX, Krumm said, noting that the new aircraft can use all the aerospace ground equipment now used for the C-model of the Eagle.

"That's all already in the inventory," he said, but the similarity

of aircraft also means “we’re looking at a transition time of months—less than six months”—to transition units now flying the C-model to the EX. “Typically, [with] an Active unit, that [process] takes 18 months; with the Guard, it takes three years.” He went on to say that “If you average that out, Active and Guard, each time we do that we save about two years of readiness,” meaning aircraft available for combat, “And that’s important for us.”

He insisted, though, that USAF is “committed to the F-35, and I think we’ve outlined that in the budget.”

Krumm, in a brief interview following a speech at AFA’s Mitchell Institute for Aerospace Studies, said the F-35 “is a game-changer” and “we won’t take one dime” out of 5th gen capability—nor will the F-15EX “take anything away from NGAD,” or Next-Generation Air Dominance, the future family of systems that will complement and/or replace the F-22 and F-35.

Brand-new F-15EXs will have strong bones and could last a long time—Krumm said 20,000 hours—meaning it could potentially serve well into the 2040s or 50s.

The Air Force has said the F-15 won’t be survivable against modern air defenses after 2028, so is it worth it to the service to spend the money to keep a non-stealthy, 1970s design into the 2040s?

“I think what we know is that we’re going to be fighting with 4th gen [aircraft] in 2028, and in 2035, we’re still going to have those,” he said. “The way to use these things is to collaborate on a network, and it’s going to be, what can those things bring to the fight faster?”

For example, the new Eagle could be a launch platform for “standoff weapons, hypersonics. ... They can go a long ways to assist the penetrating forces,” he said.

Air Force leaders have said they are seeking an early, interim hypersonics capability, and having F-15s that are not speed-limited due to their age (as current aircraft are) could be helpful in that pursuit. The F-15 design is technically capable of exceeding Mach 3, and so could accelerate a hypersonic missile close to its Mach 5-plus operating regime. That, in turn, would permit smaller booster rockets for weapons such as the Tactical Boost Glide hypersonic concept. The F-35, which was never designed to be USAF’s high-end dogfighter, has a top speed of Mach 1.6, and the first generation of hypersonic missiles is unlikely to fit inside its weapons bay.

“This is all about making the best use of the resources we’ve been given and building the best Air Force that we can,” Krumm said. The F-15EX is “what we came up with. ... We will find a way to make this the best we can. We have to, anyway, and this is a capacity we think we need.”

MORE MISSIONS FOR THE T-X, AFTER ALL

Another programmatic bombshell from the Air Warfare Symposium came when Air Combat Command chief Gen. James “Mike” Holmes said he’s put his staff to work looking at other USAF applications for the recently selected Boeing-Saab T-X advanced trainer, which will replace the T-38.

Throughout the T-X competition, the Air Force denied it was contemplating any other role for the new trainer and that the jet’s potential application to any other missions filled by the T-38—companion trainer, Aggressor, lead-in-fighter, etc.—were excluded. There was no credit given, for example, if a candidate aircraft already had designed-in wing hardpoints or wiring for weapons, as the Lockheed Martin T-50A did.

“We worked hard on making the requirements for the T-X,” Holmes explained in an Orlando press conference. “They were focused on the training mission. ... We guarded that requirement

because we wanted to hold the cost down and make it affordable, and we wanted to stick with just [those] requirements.”

Now, though, Holmes said, the Air Force can “start talking about maybe some potential other uses for the airframe.” He added “We’re very happy with the solution that we got for the T-X. ... We came in with significant savings below what was estimated.”

The change is potentially huge for Boeing-Saab, which have a contract to build some 350 T-X aircraft for the Air Force, and which, according to Wilson, was bid at some \$10 billion below USAF estimates. The Air Force has used scores of T-38s in roles other than as an advanced trainer, potentially increasing the USAF T-X buy by a similar magnitude.

Holmes said, “You could imagine a version of the airplane that could be equipped as a light fighter,” a reference to the Light Attack experiment in which the service put commercial turboprops through their paces for use in undefended airspace in notional counterinsurgency or counter-terror missions. Goldfein has since said the experiment has been re-scoped to also look at small jets, helicopters, and remotely piloted aircraft. The Air Force has said it could buy as few as 80 light attack aircraft for Special Operations Command, or as many as 300 or more if the type was included as part of the broader fleet. The service has said it wants to use the plane as a platform on which to “partner” with allied air forces that lack sophisticated fighters like F-35s or F-16s.

AGGRESSORS AND SECOND CHANCES

Holmes also specifically wondered whether the T-X would be useful as an “adversary training aircraft.” Every time a USAF combat jet is spared from having to act as a training enemy, “that’s one more sortie we can use” for combat training.

He also noted that Boeing “has been out to some of the international fairs and talking to our partner nations about what they might offer.”

Using the T-X offers the advantage of economies of scale, since adapting an aircraft already in the inventory in large numbers will make it “cheaper to operate those airplanes and sustain [them] for a long time.” He also said that Boeing’s T-X bid touted their new manufacturing abilities that will make it possible to build the T-X “faster and cheaper,” potentially getting them fielded more rapidly.

Whether any of this comes to pass, Holmes said, “will depend on a lot of things. It’ll depend on where the budget goes over the next few years. It’ll depend on the experiment that we’ll continue to do in the light-attack area,” which he noted is now open to a jet aircraft. The Air Force has maintained throughout its discussions of a new light attack aircraft that such a mission would be additive to the current combat fleet and can’t be considered as a substitute for any of it.

Holmes tempered his comments, though, by noting that the T-X isn’t the only jet that could be considered for light attack.

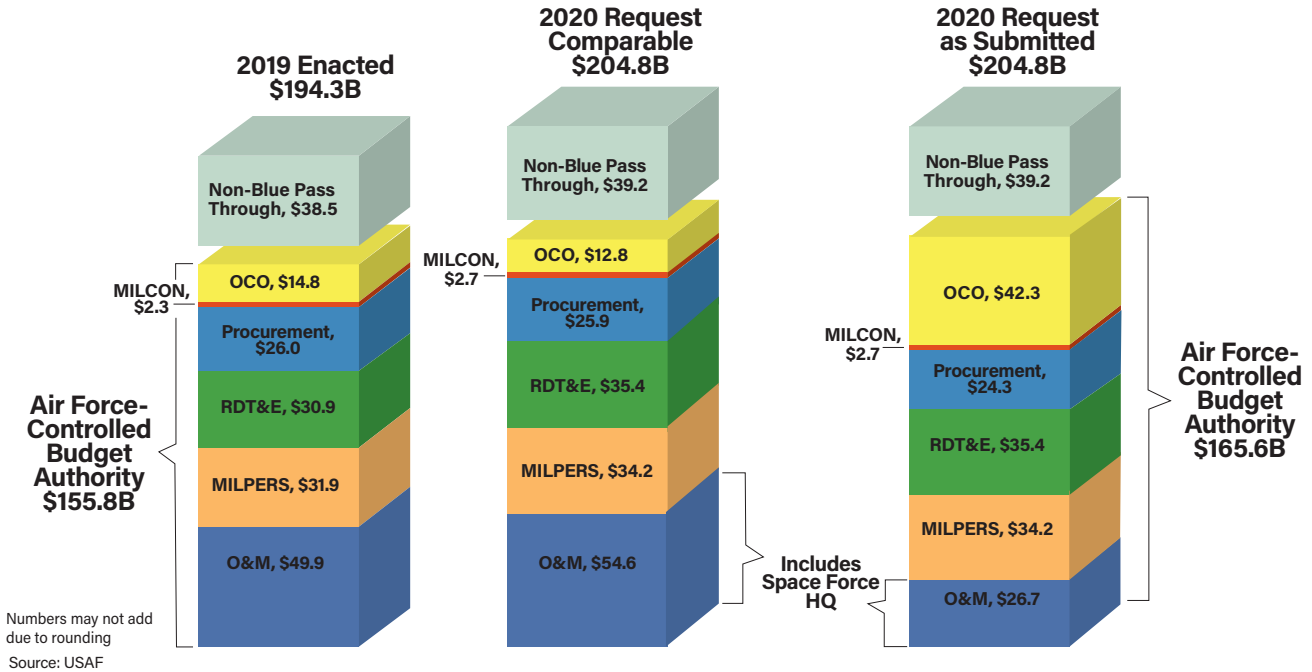
“An airplane like that, and like the competitors ... who competed in the T-X category” would also be candidates, he said. “We don’t have any conclusions,” but any aircraft of a similar size “and cost per flying hour and capability is something that I think we should definitely look at as we go forward with the experiment,” Holmes asserted.

He also cautioned that anything the Air Force cooks up will have to pass muster with the allies originally envisioned as using this approach.

“One of the primary components of anything we’re going to look at ... is going to be how our partners feel about it,” said Holmes. But as far as adapting the T-X to other missions, “those are the things that you’d expect us to look at.”

How the 2020 Budget Request Stacks Up

The president's 2020 budget submission for the Air Force is \$9.8 billion greater than the enacted 2019 spending plan, not including pass through funding. But in an effort to make the base budget fit within the 2011 Budget Control Act's mandatory spending limits, the President's request shifted \$29.5 billion into Overseas Contingency Operation (OCO) accounts. Below, the left chart represents actual 2019 spending; the center chart shows the 2020 plan as if it had been broken out the same way; and the third chart presents the budget request as submitted to Congress.



What's In the 2020 Budget Plan—And What's Not

By Rachel Cohen, Brian Everstine, and John Tirpak

The Air Force's \$166 billion budget request for fiscal 2020 includes a \$9.8 billion increase over 2019 appropriated funds and looks to start buying a new line of Boeing F-15EX fighter aircraft, includes \$72 million to begin to establish a Space Force headquarters, and adds 4,400 airmen to the Total Force.

The request is part of an overall \$750 billion 2020 Defense Department budget request that is \$34 billion, or 4.5 percent, greater than approved 2019 spending levels. The total includes \$545 billion in base defense funding, \$66 billion in war funding, \$9 billion in emergency funds, and \$98 billion that was shifted—at the White House's direction—from the base budget to Overseas Contingency Operations because of spending caps imposed by the Budget Control Act of 2011, which limits the base budget to \$576 billion.

Research and development accounts for 23 percent of the total Air Force request, including \$3 billion to develop the B-21 bomber, \$1.3 billion for land- and air-based nuclear missile modernization, and \$1 billion for next generation air-dominance projects. Advanced engine research (\$878 million) and hypersonic missiles (\$576 million) are also major areas of focus.

The budget includes \$1.1 billion to begin to buy F-15EX fighters, which would “initiate the refresh” of the Air Force's aging F-15Cs, which now average about 35 years of age. The initial payment covers eight aircraft and nonrecurring engineering costs, with the ultimate plan to acquire 80 F-15EXs in the five-year Future Years Defense Plan and as many as 144 over the life of the program—enough to field up to six squadrons.

The aircraft procurement plan also funds 48 F-35s, down from the 56 jets Congress funded in 2019, meaning the eight F-15EXs are a direct one-for-one swap, but at a higher cost per jet. At current pricing, the Air Force could acquire about 13 F-35s for the same \$1.1 billion earmarked for eight F-15s in the 2020 plan.

On March 12, Pentagon Comptroller Elaine A. McCusker said, “The balance between the 4th and 5th generation aircraft ... [was] a decision that was made by Secretary Mattis before he left.”

Army Lt. Gen. Anthony R. Ierardi, Pentagon director of force structure, resources, and assessment, said the F-35 “remains a critical program for the joint force” but the F-15EX “provides additional capacity and readiness, especially in the near years to midyears, as we look at the threats and the kinds of combat potential that we needed to bring to bear.”



Photo: DOD

Caroline Gleason, USAF civilian deputy for budget, briefs reporters on the FY20 Air Force budget on March 12 at the Pentagon.

The 2020 budget also calls for 12 KC-46s (three less than Congress directed in 2019), 12 combat rescue helicopters, and eight MC-130 special-mission aircraft, along with 12 MQ-9 remotely piloted aircraft.

Space procurement, meanwhile, is nearly flat at \$2.4 billion, missiles and ammunition increase modestly to \$2 billion and \$1.7 billion, and acquisition for other assets like cyber tools dip to \$3.1 billion.

Overseas, the Pentagon intends to reduce investment in Europe, where McCusker said the military has already changed its posture in the theater and “now we’re moving into ... exercises” and doing “other things” that are less costly.

The proposal would invest \$5.9 billion for the European Defense Initiative, down from the \$6.5 billion that will be spent this year. This “supports rotational force deployments,” adds more exercises, enhances the “prepositioning of US equipment,” improves infrastructure, and builds partner capacity, she said.

“When you look at the EDI in general, it really has five lines of effort,” McCusker said. “And only one of those lines of effort is really decreasing in the FY20 budget, and that’s the infrastructure. Because we’ve really done a lot of that work to this point.”

The Air Force plans to spend \$13.8 billion on its space enterprise in fiscal 2020, a nearly 17 percent increase over fiscal 2019, that includes a small amount of funding to stand up a new Space Force headquarters within the service.

Research and development costs account for the majority of the growth from the \$11.9 billion that was enacted in fiscal 2019, according to Carolyn M. Gleason, the Air Force’s civilian budget deputy.

Further investment in research and development will speed the Air Force’s push toward a “defendable space posture,” the service said in its budget documents. As a sole example, R&D funding for the Next Generation Overhead Persistent Infrared missile warning satellite would more than double from \$643 million in fiscal 2019 to \$1.4 billion in fiscal 2020.

Space procurement, which comprises 9 percent of all acquisition, is expected to remain flat at \$2.4 billion compared to \$2.3 billion in the current fiscal year.

The fiscal 2020 budget request funds four National Se-

curity Space launches—one fewer than the year before—as well as the procurement of the first GPS III follow-on satellite, according to the Air Force.

National Security Space Launch procurement funding—formerly the Evolved Expendable Launch Vehicle program—is set to drop from \$1.6 billion to \$1.2 billion. Production of GPS III’s 13th space vehicle, a new-start program, is slated to cost about \$415 million.

According to Pentagon budget documents, space initiatives will also require \$1.1 billion to “[reduce] risk to satellite communications jamming,” another \$1.8 billion for the GPS III follow-on and the Next Generation Operational Control System, and \$1.6 billion to improve space-based missile-warning capabilities.

“The Air Force will continue the production of Space Based Infrared Systems Space Vehicles 5 and 6 to address OPIR requirements, and Advanced Extremely High Frequency Space Vehicles 5 and 6 to meet military SATCOM needs,” the comptroller’s overview stated. “Resiliency improvements are being incorporated into the production line for SBIRS Space Vehicles 5 and 6 and AEHF Space Vehicles 5 and 6. Additional resilience initiatives will continue to be investigated and implemented where possible.”

Despite months of speculation about the details of a Space Force rollout—which still needs to be approved by Congress as part of the fiscal 2020 defense policy and spending bill debates—the Air Force revealed little information. Setting up a Space Force headquarters with 160 people would cost just \$72 million in its first year, including \$54 million for mission support and \$19 million for civilian pay, according to Air Force budget documents.

Also wrapped into the Pentagon’s \$14.1 billion space budget request is \$149.8 million in new resources for the Space Development Agency—which may eventually fall under the Space Force—and \$83.8 million for US Space Command, the newest unified combatant command that is expected to stand up this spring.

In addition, the day after the budget rollout, acting Defense Secretary Patrick M. Shanahan signed a memo establishing the SDA as the new face of Pentagon-wide space research and engineering, and he named Fred G. Kennedy to be the organization’s first director. Kennedy previously served as the director of DARPA’s tactical technology office.

“A national security space architecture needed to deter or, if deterrence fails, defeat adversary action is a prerequisite to maintaining our long-term competitive advantage,” Shanahan wrote in the memo. “We cannot achieve these goals, and we cannot match the pace our adversaries are setting, if we remain bound by legacy methods and culture.”

The Department of Defense will transfer 587 military and civilian staffers and funding from the National Space Defense Center, Joint Force Space Component Command, Joint Navigation Warfare Center, and other groups to Space Command, according to the DOD comptroller’s budget overview. Those organizations will report to SPACECOM instead of Strategic Command.

SPACECOM, which will oversee daily space operations, would total nearly 620 personnel in fiscal 2020—all but 30 of whom would transfer in, according to the Pentagon comptroller. The Air Force promises to devote “greater time and resources” to training its space operators, who will become the “cornerstone” of US Space Command as it stands up this year.

Tyndall's New Rebuild Plan: The Base of the Future

By Rachel S. Cohen

The base of the future is taking shape amid the wreckage left behind by Hurricane Michael. Tyndall Air Force Base, Fla., presents a unique opportunity to reimagine the future of coastal Air Force bases and also a pressing imperative to sustain operations in the wake of devastating destruction that damaged every structure on the base.

As Air Force officials craft a new master plan to rebuild Tyndall, interested parties from around the base and across the country are keeping an eye on developing plans. Some 450 people representing nearly 200 companies converged Jan. 31 for their first major update. A second industry day is slated for May, and major construction projects could start as soon as this fall.

Fully restoring the base will take as long as a decade. The nearly 700 facilities and about 480 buildings spread across 4.2 million square feet all need work.

"We think it's in the neighborhood of \$4.5 [billion] to \$5 billion to fix it and get it where it needs to be," Air Force Vice Chief of Staff Stephen W. Wilson told *Air Force Magazine* in an interview. "And, as we have to rebuild most of that infrastructure, it'll give us an opportunity to start fresh."

Tyndall could be the first base to install 5G wireless networks and advanced power backup systems. "We just think there's an opportunity to start, really, from the ground up because there's about 40 percent of the infrastructure there that will have to be replaced."

Col. Scott Matthews, the Tyndall Program Management Office director, said clearing debris is still job one.

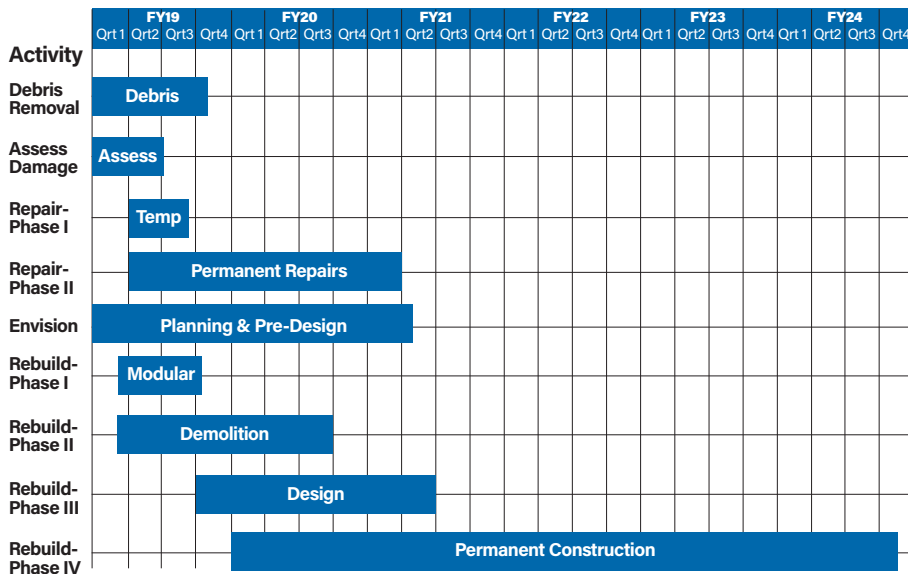
To date, the volume of fallen trees, trashed display aircraft, and other debris collected could fill the US Capitol rotunda 16 times over, according to the Air Force. While the main base is now cleared, more debris remains.

At least 44 percent of buildings require repairs, while 17 percent face immediate demolition, according to the Air Force's initial review of the base's condition. The master plan will determine how much of the remaining infrastructure could be repaired, demolished, or consolidated.

Among the facilities originally thought salvageable: the main civil engineering building, which will not be demolished. The F-22's munitions equipment storage building and the 83rd Fighter Weapons Squadron administration building, meanwhile, await a final disposition based on the master plan.

More than 200 buildings had received temporary roofs by

Five-Year Time Line



Source: USAF

the end of January. Another 135 buildings were treated for mold growing in the aftermath of 8- to 12-foot storm surges. A tornado ripped through the base earlier this year, tearing off temporary roof coverings and breaking 23 windows.

"One step forward, two steps back," Matthews said.

BRIGHT FUTURE

As the Air Force's first true "21st century" installation, the future Tyndall aims to be a walkable facility built around a "community commons"—a one-stop shop for food, shopping, and other services—and the runway. Buildings will be designed to serve multiple purposes in case of emergencies, structures will be raised above ground level to guard against flooding, and walls and roofs will employ reinforced construction techniques to survive future storms.

Lessons from the recent storm will also inform future decisions. Wilson noted that flat-roofed sunshades for outdoor aircraft maintenance crumpled under Michael's 150-mph winds, while open-ended Quonset-style structures survived with less damage.

Lessons will also be drawn from Miami International Airport and other facilities built to withstand up to 200 mph winds.

"We can [adopt] something more stringent than the local building codes," Matthews said.

Because bases need to keep operating even under extreme conditions, Wilson said, "back-up power is a really big deal." Smart grid technology, advanced turbine power systems, and even compact nuclear systems could be options, he said. "We're not there yet. We're looking to see where this goes and where technology goes."

Lessons and solutions developed for Tyndall could be applied elsewhere, as well, Matthews said.

Matthews hopes to get started on three projects costing up to \$40 million combined by the end of September. He declined to say what each project entails but said affected facilities would be away from the flight line.

MISSION FIRST

Amy Vandever, a senior planner in the Tyndall PMO, noted at the industry day that the majority of rebuilding will take place at and around the flight line. More missions could fit on the flight line by reorganizing the facilities that are housed there.

"In some cases, the ability to do single-point maintenance in a weather shelter that won't blow away in a storm may be the answer," Vandever said of more efficient, cheaper facilities. "In other scenarios, it may be combining ops and maintenance into a single facility."

Other organizations, such as the maintainers who restore low-observable aircraft coatings, could work out of temporary tents while new facilities are built.

"We're looking at what mission-related facilities we need for the F-35," Matthews said. "Where would they need to be on the flightline? What are some of the existing missions, like the Weapons Evaluation Group? Where are they today? Where could they go?"

Still, those decisions won't be entirely dependent on mission priorities. Matthews wonders whether—because the effort is such a huge, unique undertaking—stakeholders in Washington will need to weigh in as well.

Challenges include hesitancy among local contractors about the additional administrative burdens of working with the federal government, including the drawn-out background-check process and more stringent requirements for workers. Matthews said he is open to loosening base-access requirements to speed the rebuilding process, but said security restrictions surrounding the F-35 program can't be compromised.

The storm cost Tyndall most of its F-22 mission. Plans now call for making the base home to F-35s and potentially MQ-9s. The clean slate provided by the hurricane's destruction gives planners an opportunity to design a more efficient base that needs less space and costs less to build and maintain.

"When we put the master plan together we want to incorporate all future missions that we think may be here in the near or long term," Matthews said. "Instead of building maybe a hangar that only services one type of aircraft, can we do a multiuse hangar, and what would that look like? How big would that need to be?"

Tyndall's possible loss of F-22s could be a boon for others. In February, Virginia's congressional delegation wrote to Air Force Secretary Heather Wilson asking her to permanently move F-22s to JB Langley-Eustis, Va., to take advantage of excess capacity there. F-22s are temporarily located at Eglin AFB, Fla., while the Air Force considers future basing options.

"While JB Langley-Eustis currently has two F-22 squadrons, as well as supporting maintenance units, it was built for the beddown of three squadrons," the bipartisan group of 13 lawmakers wrote. "It is thereby underutilizing the airspace and Air Force investment in ramp, hangar, and operations support facilities. ... Additionally, the Virginia Air National Guard stands uniquely positioned to support the [formal training units] with experienced instructors and maintainers well-versed on the platform."

Air Combat Command chief Gen. James M. "Mike" Holmes told reporters in February the service isn't in a hurry to decide where to move the training unit and will take at least a couple of years to study its options.

PAYING THE BILL

Officials are still working the angles to come up with the money to save Tyndall. Wilson can tap only up to \$15 million from operations and maintenance funds to recover from natural disasters and terrorist attacks. Everything else will have to be either reprogrammed or direct appropriations. Reprogramming is difficult because the military construction budget is so tight to begin with, Matthews said.

In late February, a bipartisan group of senators tucked \$1.1 billion for Air Force operations, maintenance, and construction into a broader, \$13.6 billion disaster-relief funding bill. Lawmakers would allow the service to stretch more than half those funds until the end of September 2023, but want an accounting of how the money would be used.

Matthews said Wilson has an overall supplemental figure for how much money the Air Force thinks it needs to recover from the most recent hurricane season. The service has not provided that figure.

John Conger, a former assistant defense secretary for energy, installations, and environment who now directs the Center for Climate and Security, said Congress is "generally responsive" to recovery funding requests. He indicated it's unlikely the government will try to change the way it budgets for relief and recovery as climate change intensifies, noting those funds aren't subject to budget caps.

To be able to award contracts for fiscal 2019 projects, Matthews said they have to start the contracting process by the end of April. The second industry day, in May, will focus on facility and infrastructure design, construction, community partnerships, and program management.

Matthews also expects to spend about \$300 million on the first round of projects in fiscal 2020.

Looking ahead, the Air Force will need to consider the climate and how resilient a base is when deciding where to house its aircraft.

"It'll be important for other Air Force installations in the southeast and the broader region to review their ability to sustain a similar storm and how they might be able to protect important assets at the installation," Conger said. "How would JB Langley-Eustis fare if a similar storm hit it? Do they have hangars that are constructed to protect any F-22s that are in maintenance and cannot evacuate? What steps are they taking to make their base more resilient?"

Does that mean Congress shouldn't approve the Air Force's plan to put F-35s at Tyndall or perhaps F-22s at JB Langley-Eustis? Not necessarily, Conger said.

But, he argued, the Air Force will need to consider hurricanes and flooding threats to its high-value assets, as well as the risk in other regions posed by wildfires, drought, desertification, and civilian encroachment.

Climate change poses real risks for the Air Force, Conger said. If "500-year storms" become more common, the Air Force must invest to reduce the risks posed by those events. Yet while that is an enterprise-level, Air Force-wide problem, it's also one that must be addressed directly at the local level.

"Ultimately," Conger said, "customized plans that incorporate the individualized features of an installation will be more valuable than enterprise overviews." ❄



F-16Cs, such as this one flying from Eglin AFB, Fla., are the most mission-ready USAF fighters. But, at only 73.7 percent mission capable, they are still short of the 80 percent target.

Readier or Not: Fighter Force Struggling to Be 80 Percent Mission Capable

Photo: TSgt. John Raven

By Brian W. Everstine

Air Force leaders say they are on pace to achieve 80 percent mission capable rates for F-22s, F-35s, and F-16s by the end of this year through intensified maintenance and changes to basing and deployments.

“We are more ready for major combat operations today than we were two years ago,” Air Force Secretary Heather Wilson said at AFA’s 2019 Air Warfare Symposium.

Then-Defense Secretary James Mattis ordered the Air Force and Navy to increase fighter mission capable rates to 80 percent in September in order to meet requirements set out in the Pentagon’s National Defense Strategy, which called for increased availability of aircraft in case of war with a peer competitor.

At the time, the mission capable rate for F-22 was only 49 percent and for the F-35A was just 54.7. The F-16C was the most capable USAF fighter, but at 73.7 percent, still below the target.

Lt. Gen. Arnold W. Bunch Jr., the Air Force’s top uniformed acquisition official and presumed nominee to take over Air Force Materiel Command, said in February that the Air Force’s combat-rated fighters will reach the goal, but that training and test aircraft will fall short. Maintaining the low-ob-

“We are more ready for major combat operations today than two years ago!”

—Heather Wilson, Air Force Secretary

servable coatings on the F-22 Raptor and F-35A Lightning II is one of the complicating factors.

“We’re on track across the three systems,” said Vice Chief of Staff of the Air Force Gen. Stephen W. “Seve” Wilson in an interview. “Maybe the hardest is the F-22. ... But we are focused on being 80 percent across the three platforms. And how do we shift money to get the right weapons support, with the right parts, and the right manning, [and] the right people to be able to do that? ... We track it by month. Right now, we’re on track.”

BRINGING RAPTORS HOME

One way the Air Force is increasing readiness is by decreasing workload. Since 2014, F-22s have quarterbacked strike operations in the Middle East, where Raptors have conducted air strikes and escorted USAF bombers during the Syria campaign. But when the 94th Fighter Squadron wrapped up its deployment in October 2018, legacy F-15Cs took over the mission.

Air Combat Command boss Gen. James M. “Mike” Holmes declined to discuss F-22 deployments in detail, saying the key is balancing training and maintenance.

“Part of that balance is how much time can you spend on deployment, how much time can you spend at home to train—to both train young main-



Photo: R. Nial Bradshaw/USAF

Maintainers work on F-35s during Red Flag 19-1 at Nellis AFB, Nev. Spare parts shortages helped keep the jets' mission capable rates under 55 percent in 2018.

tainers into experienced maintainers and young aircrew into experienced aircrew, and to train for the threats that the National Defense Strategy told us to train for," Holmes said.

At the same time those Raptors returned, the Air Force was adjusting to the post-Hurricane Michael realities of a devastated Tyndall Air Force Base.

After the storm, Tyndall's F-22s were redistributed to JB Langley-Eustis, Va.; JB Elmendorf-Richardson, Alaska; JB Pearl Harbor-Hickam, Hawaii; and Eglin AFB, Fla. A long-term basing plan is still in the works, but for now, Langley, Elmendorf, and Hickam will increase their overall squadron size, and a small number of aircraft will stay at Eglin for training.

Holmes said maintaining 24 aircraft per F-22 squadron can help improve readiness.

"The reason is the economy of scale," Holmes said. "On any given day, you only want to commit a certain percentage of your aircraft to the flying schedule, and spend time addressing delayed discrepancies—doing planned and unplanned maintenance on the others—the more you have, the more you can commit a certain percentage of them [to maintenance]."

The two F-22 bases in the Pacific are moving toward that goal. The aircraft are already at JB Elmendorf-Richardson, Alaska, and JB Pearl Harbor-Hickam, Hawaii, and the rest of the airmen are expected to be at the base by summer, PACAF boss Gen. Charles Q. Brown Jr. said.

Last summer, the Government Accountability Office criticized the Air Force's management of the F-22 fleet and personnel, citing inefficient basing and constant Middle East deployments as undermining readiness.

"Although its high-end capabilities provide some benefits in current operations against ISIS, 39 F-22s have primarily been used for close air support missions in operations against ISIS, according to Air Force officials," the GAO wrote. "However, CAS is not a primary or secondary mission for the F-22. As such, F-22 pilot air superiority skills degrade while on deployment because they are conducting CAS missions and not able to train for their air superiority missions, according to Air Force officials."

The Air Force, in response, said it is reassessing how it bases and deploys the aircraft.

F-35 PARTS SHORTFALL

For the F-35, the largest readiness challenge is a lack of spare parts.

"The biggest bang for the buck is in parts," General Wilson said in early March. "I've got to be able to have the right parts in the right place."

Holmes said, "The goals that the Secretary of Defense gave us to work toward" are helping to shine a light on problems and to drive toward solutions.

"Do you have enough of the parts in stock that, if you picked up to go deploy, you've got your war reserves spares kit full and you can operate for a while?" he asked. "We're continuing to fill those out."

FOCUS ON PEOPLE

The squadrons that have the best readiness are the ones that are fully manned with maintainers. A servicewide maintainer shortage has contributed to the readiness problem, and even though that gap has been closed in gross terms, the Air Force continues to struggle with experience and knowledge shortfalls among maintainers.

"Some of our squadrons are able to achieve that [80 percent readiness] now in places where we're fully manned and have more experience," Holmes said. "The last number I pulled for ACC said we're manned at 100 percent and a bit better for maintainers, but we still have a lot of ... brand-new maintainers that are gaining experience."

In addition to adding new maintainers, the Air Force is also adding additional maintenance shifts and hiring contractors to help. Adding a night shift to an F-16 squadron means that a Viper in need of repair after a training flight can be fixed overnight so pilots can fly the next morning, Wilson said. Without that extra shift, it might take another day to get that jet back in the air.

"We're about 15 percent better than we were last year," Holmes said. "That's largely because of the people"—being fully manned. "That's pushed some of the squadrons over the hump." ❖

EW Study Yields More Questions



An artist's concept of a Gulfstream G550, outfitted to carry the Compass Call's upgraded communications, sensor, and radar equipment.

Illustration: Gulfstream

By Rachel S. Cohen

After a year-long analysis of its electronic warfare capabilities and requirements, the Air Force is still searching for answers.

While some leaders press for an enterprise approach to EW, others worry further delays will handicap US forces engaging with increasingly sophisticated challengers.

The Air Force should take a broader, force-wide look at electronic warfare instead of its conventional platform-by-platform approach, says the four-star head of Air Combat Command.

"We haven't had to concentrate on [EW] in the last 15 years of war in permissive environments against Middle East" combatants, said Gen. James M. "Mike" Holmes at AFA's Air Warfare Symposium last month. "We could operate where we wanted to, when we wanted to, with our air assets."

Not anymore. "It's time for us to do some re-look," he said.

There's no time to waste, says Pacific Air Forces commander Gen. Charles Q. Brown Jr. Each day the Air Force spends considering how to approach EW in

"We could operate where we wanted to, when we wanted to, with our air assets."

—Gen. James Holmes, head of Air Combat Command

the future results in a day's delay in acquiring future combat assets. In a March 1 interview with *Air Force Magazine*, Brown argued it is "an issue we've got to be looking at today."

"The Air Force that we're going to fight with five years from now is the Air Force we have today," he said. "The electromagnetic spectrum will be an area that will be contested, whether it's [communications], whether it's our ability to use our radars, whether it's the ability to use our links."

The Air Force convened an Enterprise Capability Collaboration Team at the start of 2018 to delve into EW policy and procurement to ensure EW dominance through 2040.

"Analysis will review EW in the context of non-kinetic stand-in/standoff operations against enemy integrated air defense systems," the Air Force said in January 2018. "Additionally, the team will consider directed energy, cyber delivery, and space capabilities."

To date, the study's findings have not been made public.

EW is often cited as a key threat in highly contested environments. In its 2019 Worldwide Threat Assessment, the US Intelligence Community warned that

An EC-130H
Compass Call at
Davis-Monthan
AFB, Ariz., in
2017.



Photo:ATC Mya Crosby

Russia is expected to particularly focus on advancing its EW capabilities this year.

Brown says airmen who are unfamiliar with EW need to prepare for that new reality and to understand that interference may not be just a blip on their screen.

“Part of this is increasing awareness that it’s a risk or a threat, and then on top of that ... how do we capture it and be able to analyze it going forward?” he said.

RAND Corp. researchers wrote last November that, “absent a forcing function, staffs tend to default to emphasizing traditional physical capabilities and their effects in planning and execution.”

Yet, Holmes said, jamming or confusing adversaries’ software complements conventional weapons and can “complicate the calculus” in battle. It can also expand the battlespace, opening access to airspace by disabling air defenses.

In Brown’s view, this will require a combination of existing EW pods, new creations from industry, and the Navy’s EA-18G Growler aircraft.

Upgraded legacy technology will also be critical. L3 Technologies is moving upgraded communications, sensor, and radar equipment from legacy Compass Call aircraft to the Gulfstream G550 for the Air Force. The new EC-37B Compass Calls will be the Air Force’s “premier wide-area coverage airborne electronic attack, offensive counterinformation weapon system,” the service said.

Going forward, the Air Force must develop new technologies that can outlast the countermeasures imposed by rival militaries, Holmes said. Enemy systems today can operate in spectrum surpassing the traditional bands used by surface-to-air and air-to-air radars.

For every US system in place, “you can see that they’ve laid in a system designed to try to counter, specifically, that system across the whole bandwidth ... in all the areas that we operate,” Holmes said.

It’s not enough to play this continual game of cat-and-mouse, he argues. Rather, the US should change the game altogether.

“Are we going to try to counter the counter to our counter?” Holmes asks. “Or are we going to go somewhere else and do something different?”

From an industry perspective, the opportunities are substantial. The Defense Department will spend more than \$5 billion on EW research and development in Fiscal 2019 and continue to spend at least \$4 billion annually through Fiscal 2023, *Inside Defense* reported last fall.

Some of the more advanced development efforts underway are the Air Force’s F-15 Eagle Passive Active Warning Survivability System and B-2 Defensive Management System, the Navy’s Next Generation Jammer and Advanced Offboard EW systems, and the Army’s Common Infrared Countermeasures program, according to Bill Conley, the Pentagon’s EW director for acquisition and sustainment.

A department-wide approach to electronic warfare is still in the works, and debate continues to simmer over whether the electromagnetic spectrum should be counted as its own domain. As the Pentagon tries to answer that question, responsibility for waging electronic combat could shift between combatant commands.

Strategic Command advocates for combatant commands to add EW into their regular battle rhythms, while the Joint Staff in recent years has looked at ways to coordinate how each service uses the electromagnetic spectrum.

Air Combat Command organizes, trains, and equips EW forces alongside the intelligence, surveillance, and reconnaissance mission under 25th Air Force. The service is considering how to properly merge those missions with cyber operations, which are managed by 24th Air Force and recently joined ACC. A similar restructuring is underway within the Air Staff.

Inside Defense reported in November 2016 that Maj. Gen. Edward A. Sauley III, then a one-star Air Force general serving as STRATCOM’s deputy director of joint electromagnetic spectrum operations, speculated that US Cyber Command could take responsibility for electronic warfare by the mid-2030s.

“I think electronic warfare and cyber capabilities will come awful close together, so they will merge a little bit,” he said at an Association of Old Crows conference. “Where does advanced electronic attack end and cyber begin? Sometimes it’s more of a personal opinion and—a lot of times—boils down to legal authorities and how that line is drawn between the two. The line does get blurred.”

Life After JSTARS

The ABMS Will Test Roper's Vision for Incremental Development.

By Amy McCullough

The Advanced Battle Management System could point the way toward a radically new acquisition model for the Air Force—but first, the service needs to get a better handle on what ABMS is going to include.

ABMS is an open architecture family of systems the Air Force hopes to develop in place of the canceled E-8 Joint STARS recapitalization program.

Defining ABMS may not be easy, but that's the point. "The way our acquisition system works now, we presume we're smart enough to know the right design before we bend metal. That's crazy. There's a huge trade space to explore," Will Roper, assistant secretary of the Air Force for acquisition, technology, and logistics, said in an interview.

The Air Force knows it wants the system to include a space component, an air component, and a command and control component, but how those work together, or which element might be more dominant, is still undetermined.

So rather than creating one massive acquisition program, Roper envisions multiple contributing programs, such as ABMS space, ABMS air, and ABMS networking and communications—each with its own funding, its own program manager, and its own schedule. The program manager would be tasked with pushing the program as far as possible over two to three years, after which the service can "reevaluate what the next segment of the race should be and how it should be run," Roper said.

While each of the program managers will be experts in their field, an overarching "architect" will oversee the big picture. Reporting directly to Roper, that person will be Preston Dunlop, formerly an executive with the Johns Hopkins Applied Physics Laboratory.

In a March 1 interview with *Air Force Magazine*, Roper said the architect will spend a significant amount of time modeling and simulating how ABMS could work. The architect likely will have a small staff and leverage federally funded research and development centers or academic institutions, such as MIT's Lincoln Laboratory or APL for analytical expertise and support.

"We're going to try to avoid making the major defense acquisition program mistake, and instead, create a new role that we currently don't have in defense acquisition," Roper said. "An architect, at least in theory, will be defined by the ability to do technical trades that flow back into the programs."

Acknowledging that ABMS has gotten off to a slow start, Roper promised the program will pick up pace with his new hire.

The first phase will focus on developing the technology, with multiple goal lines defined by



Photo: Mike Tsukamoto/staff

Will Roper, assistant secretary of the Air Force for acquisition, technology, and logistics, envisions multiple small programs, rather than one big one, to find the next battle management solution.

"The way our acquisition system works now, we presume we're smart enough to know the right design before we bend metal. That's crazy."

—Will Roper, Air Force acquisition chief

the architect. The more progress each individual program manager makes in the allotted time, the more funding will be available for the next phase of development. This way, Roper said, "you're incentivized to go big."

Then, "at that chalk line in time, we'll evaluate whether we have pushed the technology enough across those different domains to converge to an architecture that we call Advanced Battle Management System," Roper said. "If you have, great. You integrate it, then go field it. If you haven't, then you evaluate who did well and who didn't, and if someone is further behind with an option to catch up, then you may terminate their tech push and shift it to someone else that still has the ability to go further. That's where you could see the architecture shifting" to a more space-centric or air-centric model, depending on where the most progress is seen.

The second increment likely will be distributed unevenly across the components, because each component is bound to mature at different rates. Dunlop will serve as the "honest broker," Roper said, helping to motivate program managers to smartly take on risk.

"It will be very much a tech-push program initially with rigid delivery times," he said. "If that technology does not make it, then it will have to go to the next variant. Keeping that constant delivery cadence to see if a design converges that can do the ground moving target indicator mission."

Roper is already looking at other places this process could be implemented. He's spoken with combatant

commanders and training leaders about how it could be used in training opportunities. Because the Air Force's training needs are distributed across the country and utilize a variety of different trainers and simulators, each representing different missions and threat scenarios, this approach could have merit there, he said.

Another possibility could be the Next-Generation Air Dominance (NGAD) system. Though he declined to provide much detail, saying he doesn't want to "tell the world what we think the next generation of airpower will be"—he said a family of systems that allows for a diversified portfolio of options would make sense there, as well.

For now, though, ABMS is the focus. "During the next phase of my tenure in acquisition, I think getting ABMS right is a critical thing," Roper stated. "It creates a new model in acquisition where when we have to create an integrated system—or a family of systems—we don't automatically default to a Future Combat System-type program."

The Army's ambitious Future Combat Systems program set out to replace virtually its entire vehicle fleet. Once envisioned as a \$25 billion acquisition extravaganza, it was canceled in 2009—a massive flop.

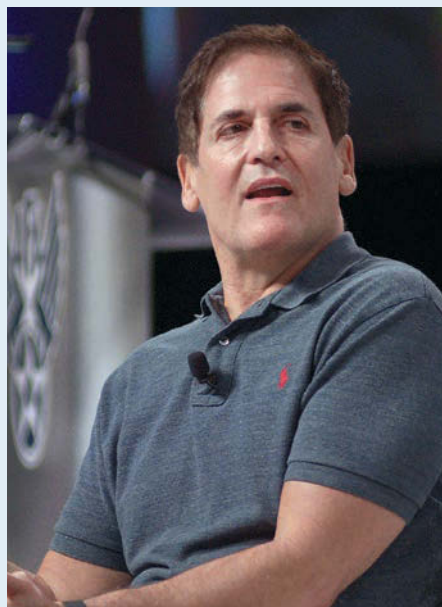
"The program of programs has not worked very well in the past," Roper said. ❏

10 Things Every Airman Can Learn From ... Mark Cuban

By Jennifer-Leigh Ophirory

Shark Tank star, Dallas Mavericks owner, and serial entrepreneur Mark Cuban shared the stage at AFA's 2019 Air Warfare Symposium, where he helped judge this year's Spark Tank innovation competition and joined Air Force Vice Chief of Staff Gen. Stephen W. "Seve" Wilson for a chat about business, innovation, and gearing up for an uncertain future. Here are 10 takeaways any airman can use to innovate, lead, and make the Air Force a better place.

- 1. Don't be afraid to take that first step.** If you come up with an idea, a better way to do something, or a new way to solve a problem, that's only the beginning. The hard part is turning the idea into action. "All of us have had ideas that we thought were gonna be the next great thing," he said. We share those ideas with a friend or colleague, they love the idea, but then we stop. What sets entrepreneurs apart is that they take that next step. "That's something each and every one of us can do. So, the best advice that I can give you is, do it."
- 2. Failure is OK.** Entrepreneurs aren't always successful. Indeed, Cuban admitted to plenty of failures—including an ill-fated attempt to sell powdered milk. (Turns out taste and texture matter). Failure is just a way of learning. "There's no box score for your failures, so go big because the worst thing that'll happen is, OK, maybe... you can't get quite that far, but, you can get almost there," he said. "You get that first step."
- 3. Think differently.** The most valuable ideas are those that tackle problems in unique ways. "I look for something that is unique and differentiated first," he said. Ask what competitors are doing. Why is your idea better?
- 4. Don't drink the Kool-Aid.** "The thing we all do as entrepreneurs [is] we lie to ourselves," he said. "Bigger" and "Best" claims raise flags in his mind. Be realistic about what your solution delivers.
- 5. Be obsessed.** Creativity and great ideas only get you so far. Bringing those ideas to reality is plain, hard work. What makes Cuban decide whether or not to invest, he said, is the passion the entrepreneur has for the product. He wants "somebody who is living, eating, sleeping, breathing their business because, if it's not so compelling to you that it's all-consuming, why are you doing it?" Love your work so much you dream about it.
- 6. Know your competition.** To overcome competitors, you've got to know what they have and be able to articulate how you will take that on. "If the entrepreneur has done those things, then chances are, I'm gonna be very



Mark Cuban, businessman, investor, and owner of the Dallas Mavericks basketball team, said anyone can be an entrepreneur if they try hard enough.

Photo: Mike Tsukamoto/staff

interested," Cuban said.

- 7. Analyze every aspect, not just one. In any innovation, there is more than one critical variable or area of concern.** For example, in artificial intelligence, one can get so caught up in data capture and algorithms that you lose track of trends in computer processing. But a change in processing could change your approach to data and software. Innovators must understand all the moving parts to ensure that ignorance doesn't result in accidental disaster.
- 8. The mind matters.** Cuban said his decision to hire a team psychologist for the Dallas Mavericks was one of his greatest contributions as an owner. How we deal with stress and function under pressure affects not only our performance, but can also impact those around us.
- 9. Mission counts.** "If you wake up each and every morning knowing you're contributing to something that's important to you, that you matter, what's more successful than that?" he said. Define success for you and then make that your focus.
- 10. Hit the books—and the Internet.** When Cuban wanted to get smart about artificial intelligence and machine learning, he educated himself. He found online video tutorials and said he has *Machine Learning for Dummies* in his bathroom. "All it takes is reading it and learning it," he said. If you want to know more about something, take the initiative: Teach yourself. ❏

Need for Airdrops Skyrockets in Afghanistan



Photo: SSgt. Benjamin Gonsier

A C-130J takes off from Bagram Airfield, Afghanistan. USAF saw a huge increase in airdrops over Afghanistan in 2018—most flown by Super Hercules crews and airmen from Little Rock AFB, Ark.

By Brian W. Everstine

The number of airdrops conducted in Afghanistan last year increased nearly 1,900 percent from 2017, and the airmen tasked with providing this capability to US and allied forces on the ground did so at a perfect rate.

In 2018, US aircraft air-dropped a total of 667,880 pounds of supplies across Afghanistan, up from just 33,423 in 2017, zero in both 2016 and 2015, and just 28,000 in 2014. In 2013, the last time US aircraft flew a higher rate of airdrops, the US military had more than 65,000 troops in the country, compared to about 16,000 in mid-2018.

The increase was coupled with a dramatic spike in air strikes—2018’s total of 7,362 was more than the previous three years combined, and the highest total since at least 2009, according to data provided by Air Forces Central Command.

These numbers show the fight in Afghanistan is far from over. Even as US negotiators work toward a framework for peace with the Taliban, ISIS-Khorasan remains a threat. AFCENT, in a statement to *Air Force*

We operate in a dynamic, ever-changing AOR [area of responsibility], and therefore the movement of assets and resupply missions vary;

—Capt. Holly Brauer, AFCENT spokeswoman

Magazine, would not specifically provide details on how its operations changed, saying only that weather changes, the movement of forces, and resupply needs can shape how mobility missions occur.

“We operate in a dynamic, ever-changing AOR [area of responsibility], and therefore the movement of assets and resupply missions vary,” AFCENT spokeswoman Capt. Holly Brauer said in a statement.

The huge increase in airdrops, which were largely flown by C-130Js and airmen primarily from Little Rock AFB, Ark., can be attributed to the evolving fight.

“The difference I noticed wasn’t a change in the pace of operations or a build up and draw down. It was more where we were ... flying into. It was where the fight was being fought,” said Capt. Michael Morrison, a C-130J pilot with the 41st Airlift Squadron. Morrison couldn’t say exactly where the fighting was taking place, but he said the more remote, mountainous areas did not have “a suitable airfield, so we have to do the airdrop instead.”

In January 2018, when the airmen and aircraft from Little Rock deployed to Bagram Airfield, Afghanistan, the pace of airlift operations was “business as usual.”

Aircrews flew approximately every other day, about four lines per day, doing “air-land” cargo deliveries—meaning they would land on a remote airstrip at an established forward operating base.

However, as the deployment progressed, operations in Afghanistan shifted. US, coalition, and Afghan forces fought more in eastern Afghanistan, in places like the remote and mountainous Nangarhar province, against ISIS-Khorasan fighters who had holed up in these harsh areas. Also in early 2018, the Army deployed its first Security Forces Assistance Brigade to rural outposts to train small units of Afghan forces in areas closer to Taliban strongholds and to assist soldiers who needed regular resupply. These SFAB teams augmented existing US and allied Expeditionary Advisory Packages deployed with Afghan forces throughout the country.

Aircraft were needed to supply forces in rough areas and operate at a pace that was “minimizing our level of exposure,” said Capt. Jonathan Cordell, a C-130J pilot with the squadron, who was the tactics officer while deployed.

This meant more remote forward operating locations, without airstrips, and in contested areas. Resupplies had to be rethought, and the Combined Air Operations Center at Al Udeid AB, Qatar, soon called on the C-130Js to air-drop supplies.

From the beginning of the deployment until the end of March, there was not a single pound air-dropped in Afghanistan. By the end of April, aircraft had dropped 135,840 pounds, with 191,400 more in May, and 126,000 pounds air-dropped in June. The rate dropped through the end of summer before picking back up at the end of the year, according to AFCENT data. The increase in airdrops “is something—to be honest—no one really had expected to do once we got out to Afghanistan,” Morrison said. “We knew it was definitely a possibility, and we could carry out that kind of stuff.”

At first, the C-130Js solely landed and rolled off cargo, but by late spring, they were flying airdrop missions roughly once per week.

“It’s a tribute to the C-130’s flexibility, and our ability to go anywhere, anytime. We’ll carry out the mission and get it done,” Morrison said. “We do that better than any airplane.”

In May 2018, C-17s got back in the fight, when an Al Udeid-based Globemaster dropped more than a dozen pallets in southern Afghanistan—the aircraft type’s first airdrop within the US Central Command AOR in 18 months. The Afghan Air Force also increased its capability, with its first emergency airdrop from a C-208 in June of that year.

The Little Rock crews tallied a 100 percent recovery rate throughout their deployment, which ended in June—their pallets landed on-target, and friendly crews were able to pick them up immediately. After the drops, aircrews would make sure to connect with the ground forces to ensure everything was picked up, and plan ways to improve the process for future drops, Cordell said. Sometimes the soldiers would make personal requests, but, unfortunately, the aircrews were “not a part of that decision-making process,” he said.

The missions were planned days or weeks in advance, with soldiers working with loadmasters to prepare the bundles for airdrops after tasks came in from the CAOC. Airdrop missions took more time to prepare because the bundles had to be outfitted with parachutes and readied to be tossed out the back of an aircraft. But it also allowed for a faster turnaround on missions. At times, an aircraft could air-drop a load of supplies, then land to roll on more pallets for a traditional air-land mission right away, said A1C Matt Madson, a C-130J loadmaster with the squadron.



Photo: SSgt. Benjamin Goncier

A1C Dominick Partlow marshals a C-130J at Bagram Airfield, Afghanistan.

At one point in early May, a Resolute Support Expeditionary Advisory Package in a remote mountainous area needed a large resupply, one that couldn’t be carried by one C-130J. Instead of using a different aircraft, such as a C-17, or doing multiple passes into a hostile area, the CAOC brought in another C-130J and airmen from the 746th Expeditionary Airlift Squadron at Al Udeid Air Base comprised of Reserve airmen deployed from the 403rd Wing at Keesler AFB, Miss. The two C-130Js flew in tight formation through the night to drop the supplies nearly simultaneously to the friendly forces. This type of mission was “more tactically sound, with less exposure time,” pilot Capt. Christian Fontaine said.

It was the first time C-130Js from separate bases, in different countries, flew a dual-formation airdrop in the 18-year-long war. The two squadrons practiced the exact mission set before deployment, during spin-up training at the Green Flag-Little Rock training exercise in Arkansas. These types of missions are conditioned regularly back home, but had not been flown in Afghanistan under the same circumstances.

The mission provided lots of equipment to soldiers on the ground safely and was a “timely, awesome proof of concept,” said Capt. Mark Hunkins, a C-130J pilot with the squadron.

As the deployment progressed, the airmen and mission planners were able to refine their tactics and capability. Maintainers kept the aircraft at a high mission capable rate, because “canceling a line, that means people and cargo aren’t getting to where they need to,” Morrison said.

“We pride ourselves in being professional aviators,” said Morrison. “We want to be the guys in the squadron that the Army calls when they need something done. We want them to call us first. We don’t want them to call C-17s. ... We want them to call us. We can take care of them, they know what they’re going to get, and they’re going to get it on time.”

Secretary Wilson Will Resign, Lead University of Texas at El Paso

Air Force Secretary Heather Wilson resigned effective May 31 to become president of the University of Texas at El Paso after two years as the service's civilian leader.

"I am proud of the progress that we have made restoring our nation's defense," Wilson said in a statement. "We have improved the readiness of the force; we have cut years out of acquisition schedules and gotten better prices through competition; we have repealed hundreds of superfluous regulations; and we have strengthened our ability to deter and dominate in space."

If a new nominee is not confirmed by her departure date, undersecretary Matt Donovan will fill the top job until a new Secretary is confirmed.

In her March 8 resignation letter, Wilson said she expects to start her new job Sept. 1.

"This should allow sufficient time for a smooth transition and ensure effective advocacy during upcoming congressional hearings," she wrote.

Wilson has held prior leadership roles in academia and the University of Texas El Paso is close to her family's home in New Mexico.

A strong proponent of broadening the military's outreach to research universities, Wilson would return to a familiar career in academia. She left the South Dakota School of Mines and Technology after four years as its president to become Air Force Secretary and has since pushed to modernize the service's ac-



Photo: Mike Tsukamoto/staff

Secretary of the Air Force Heather Wilson will depart the Air Force May 31.

quisition and science and technology enterprises.

A former member of Congress who is widely respected on Capitol Hill, Wilson had been seen as a possible successor to James Mattis as the next Defense Secretary and the first woman to fill that post.

"The importance of her incredible work in the Air Force cannot be overstated," Rep. Mike Turner (R-Ohio), the ranking member on the House Armed Services strategic forces subcommittee, said. "It is not surprising to me that Heather would be sought out by other organizations looking for her strong leadership. ... Hopefully, someday we can see Heather Wilson as the first female Secretary of Defense." —Rachel S. Cohen

Tribute

George K. Muellner: 1943-2019

By John A. Tirpak

George Muellner, retired Air Force lieutenant general, fighter pilot, test pilot, a classified programs specialist, a top technologist for Boeing, a senior leader of the aerospace industry, leader of a number of aerospace societies and associations, and former Air Force Association Chairman of the Board, died Feb. 11 in Newport Beach, Calif. He was 75.

Muellner earned his commission through the ROTC program at the University of Illinois, after earning his bachelor's in aeronautical and astronautical engineering. He later earned three master's degrees: in aeronautical systems management, electrical engineering, and business administration. During his career he also completed the Naval War College and Air War College.

Joining the Air Force in 1968, Muellner learned to fly the F-4 Phantom, and in the course of two tours in Southeast Asia, amassed 690 combat missions during the Vietnam War, receiving three awards of the Distinguished Flying Cross and 27 awards of the Air Medal, among other decorations. On one mission, he was shot down and made a narrow escape from enemy forces by clinging to the skids of a helicopter.

In 1973, he became a test pilot, and over the next nine years flew a wide array of aircraft, amassing a lifetime total of 121 different types. He flew operational tests on the then-new F-15 and was a member of the F-16 Combined Test Force.

Muellner then joined, and later commanded, the 6513th Test Squadron, known as the "Red Hats," where he was involved in obtaining and testing Soviet-design combat airplanes used for technical evaluation and to provide high-fidelity air combat training of US fighter pilots.

After Air War College, he served in a variety of assignments in Europe from 1983-1987, flying the F-15 and F-16, concluding with a tour as director of operations for the 36th Tactical Fighter Wing at Bitburg AB, Germany; the "tip of the spear" for the US during the Cold War.

Back from Europe, Muellner worked in the requirements shop at Tactical Air Command at Langley AFB, Va. He then went into program management. While he was directing the Joint Surveillance Target Attack Radar System program, the first Gulf War erupted. Muellner formed and commanded the 4411th JSTARS Squadron and took two experimental E-8 JSTARS aircraft to the war, years before the system would go through initial operational test and evaluation. The JSTARS were pivotal in detecting the Iraqi move against Khafji and directing attacks on those and follow-on forces to the north of the Kuwaiti border. The deployment signaled an end to US adversaries being able to move ground forces under cover of darkness.

Muellner then went back to be the deputy chief of requirements at TAC, and at its successor, Air Combat Command. A Pentagon job followed, as director of command and control



Staff photo by Mike Tsukamoto

George Muellner, then-AFA Chairman of the Board, speaks at an AFA event.

and weapon programs under the assistant secretary of the Air Force for acquisition.

In 1993, Muellner was appointed to head the Joint Advanced Strike Technology (JAST) program. Its mission was to harmonize the requirements of the Air Force, Navy, and Marine Corps for a new combat aircraft that would be used by all three services. Muellner's task was to establish the parameters of the new fighter—meeting unique service requirements for speed, range, carrier operations, vertical landing, etc.—in a largely common airframe that could save money by achieving production scale on spare parts, training systems, software, etc. The result was the Joint Strike Fighter program, and a flyoff between the Boeing X-32 and Lockheed Martin X-35. The latter was selected, and became the F-35, which is planned to be the “backbone” of USAF's fighter force.

Muellner's last USAF assignment came in 1995, when he served as the top uniformed deputy to the assistant secretary for acquisition. In that position he oversaw production of the F-22 fighter and B-2 bomber, C-17 airlifter, and a variety of classified and unclassified projects, such as the Joint Air-to-Surface Standoff Missile, or JASSM. He retired from the Air Force in 1998, after 31 years of service.

He joined Boeing that same year, serving at first as vice president and general manager of Boeing's Phantom Works advanced research and development unit, later becoming president in 2001. The following year, he became vice president and general manager of Air Force systems. He then became president of advanced systems, integrated defense systems.

Among the classified products produced under his Boeing tenure were the stealth helicopters involved in the raid that killed Osama bin Laden, which were based on technology developed for the Boeing-Sikorsky RAH-66 Comanche helicopter the Army had canceled.

He retired from Boeing in 2008, continuing as a consultant to the company. He also served on a number of corporate boards.

Muellner continued to provide leadership, mentorship, and advice through the years that followed. He served as president of the American Institute of Aeronautics and Astronautics, as a member of the Air Force Scientific Advisory Board, Defense Science Board Intelligence Task Force, and vice chairman of the Board of the Aerospace Corporation.

Muellner was virtually a lifelong member of the Air Force Association, holding many positions over the years with the Aerospace Education Council and at all levels of the organization. He was Chairman of the Board from October

2012 through September 2014, and during his tenure he nurtured and expanded AFA's CyberPatriot program, which involves middle and high school students in a cyber defense competition. He oversaw an agreement for AFA to take over the Wounded Airmen Program from the Air Force, which provides assistance to wounded Air Force personnel as they return from war. Muellner also represented AFA on Capitol Hill, articulating the importance of air, space, and cyber power.

He established the George and Vicki Muellner Foundation Scholarship, which provides annual scholarships for deserving students in the Arnold Air Society and Silver Wings—AFA sister organizations for college students.

Among his many honors, Muellner received the Defense and Air Force Distinguished Service Medals and the Legion of Merit; he was elected to the National Academy of Engineering; a Fellow of the Society of Experimental Test Pilots; a Fellow of the Royal Aeronautical Society, AFA's Theodore von Karman Award; the National Defense Industrial Association's Bob Hope Distinguished Citizen Award; the Aerospace Test Pilot Walk of Honor; and *Aviation Week's* Curtis Sword Award.

“We are saddened by the loss of a model airman, model leader, and model friend,” said retired Gen. Larry Spencer, former president of AFA. “George Muellner was a force for the Air Force, AFA, and our country. He will be missed.”

■ **CYBERCOM Chief: 133 Cyber Teams Will Be Insufficient as Adversaries Improve**

US Cyber Command views its existing cadre of cyber warriors as a starting point for growth as the Pentagon pivots to compete with more tech-savvy adversaries, the command's top general told lawmakers in February.

Army Gen. Paul Nakasone, who also directs the National Security Agency, said at a Senate Armed Services Committee hearing he expects to need more people to conduct operations as adversaries improve. The US is chiefly concerned about mounting threats from Russia, China, North Korea, Iran, and some non-state actors.

“As we measure our readiness against what we consider a number of different adversaries, primarily both near-peer and rogue states, we believe that the teams that we've created right now is the building block for that,” Nakasone said. “We are also ... building a series of defensive teams in the Army Reserve and the National Guard that are going to be a strategic depth for us.”

After some delays, the Pentagon finished creating 133 Cyber Mission Force teams with members from all three services last year. While the Defense Department has other groups that also wage offensive and defensive cyber operations, the new teams report directly to CYBERCOM and reflect the government's recent embrace of network combat.

More than 6,200 soldiers, sailors, airmen, Marines, and civilians tackle four missions as part of the Cyber Mission Force, according to the Pentagon. Cyber national mission teams find enemy activity, block their attacks, and defeat them. Cyber combat mission teams supply cyber operations for combatant commanders around the world. Cyber protection teams defend DOD networks, are assigned to “priority” missions, and prepare offensive cyber forces for combat. Cyber support teams provide analysis and planning support to national and combat mission teams.

The challenge, Nakasone said, is to retain the best of the best — those he calls “10 or 20 x type of people” because they are 10 and 20 times better than their cohorts at developing software, analyzing malware and coding. —Rachel S. Cohen



Photo: Darcie Ibdapo/USAF

Air Force cadets in formation near the chapel on the grounds of the Air Force Academy in Colorado Springs, Colo.

■ **Report: Air Force Academy Has a Sexual Assault, Unwanted Sexual Contact Problem**

Nearly half of female Air Force Academy cadets said they were sexually harassed during the 2017-2018 academic year—but only one formal report was filed, according to a new Defense Department report on sexual harassment and violence at the nation’s three military academies.

In all, 46 percent of Air Force Academy cadets reported being harassed, compared with 48 percent of female cadets at the Military Academy at West Point and 56 percent of female midshipmen at the Naval Academy.

A DOD survey of students from all three schools also found that the number of female Air Force cadets experiencing unwanted sexual contact—defined as anything from being sexually touched without consent up to and including rape—rose from 11.2 percent in 2016 to 15.1 percent in 2018. However, only 13 percent of all female academy cadets said they reported these attacks.

West Point also saw an increased rate of unwanted sexual contact since 2016.

The report cited several “concerning climate-related trends,” including:

■ Decreased willingness from cadets of both sexes to call out fellow cadets when gender-related rhetoric “crossed a line.” as compared with the previous period.

■ Decreased willingness from cadets of both sexes to seek institutional help to stop sexual harassment among classmates.

■ Decreased number of female cadets who believed academy officers’ actions and speech “set good examples.”

Fewer female cadets did express faith, however, that senior Academy leaders “made honest and reasonable efforts to stop sexual assault and harassment.”

Air Force Secretary Heather Wilson, herself an academy graduate, said the report predated a number of changes made at the Academy in 2018. She also expressed concern that cadets lacked faith in their peer leaders at the school.

“These are going to be lieutenants dealing with operational units, some of them within months or a few years,” Wilson said. “They, as young leaders, need to look carefully at the culture within their unit, as the cadet wing, and tell us what they think they can do to impact that culture.”

Air Force Academy Superintendent Jay Silveria said the academy “will aggressively” advance a nationwide conversation about stopping sexual assault and harassment on college campuses.

Wilson also said the nation’s service secretaries agree that the academies “need to lead on this issue.” The military schools have better, deeper, and more current data than most civilian schools and a track record of implementing successful programs to combat negative behavioral trends. “The Naval Academy will host the first national summit on sexual assault prevention and response” this spring, with support from all of the military services.—Jennifer-Leigh Oprihory

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■ Barksdale Tests Upgraded B-52 Weapons System

Airmen at Barksdale AFB, La., are testing an upgrade to the B-52's weapons systems that can nearly double the amount of smart weapons carried by the bomber. The 49th Test and Evaluation Squadron, in concert with other Barksdale units, recently installed an upgraded Conventional Rotary Launcher to a bomber at the base, which increases the launcher's payload from four smart weapons each to eight. The test included eight AGM-158 Joint Air-to-Surface Standoff Missiles. With the new system, a B-52 can carry 20 smart weapons on the launcher and pylons under the wing, as opposed to the current total of 16, according to a Barksdale release. "Now, a B-52 going into a war zone has the ability to put 20 munitions on a target area very quickly," SMSgt. Michael Pierce, the 307th Maintenance Squadron aircraft armament superintendent, said in the release. "Before, they would have to drop some of their munitions, power up the CRL again, and then make another pass."



Photo: SrA. Philip Bryant

A B-52 during Global Thunder at Barksdale AFB, La., in November.

■ US Conducts Open Skies Flight Over Russia

An Air Force OC-135B began conducting Open Skies Treaty observation flights over Russia in February, the first time the specially equipped aircraft has flown in that country in almost a year-and-a-half because of an "impasse" regarding treaty member nations.

The OC-135B, assigned to the 55th Operations Group at Offutt AFB, Neb., began observation flights Feb. 21, flew through Feb. 22, and departed Russia on Feb. 23, Pentagon spokesman Lt. Col. Jamie Davis said in a statement. Russia was made aware of the flight on Feb. 12, and six Russian observers were on board the flight, per treaty procedures.

The US and Russia have regularly conducted these flights since the treaty went into effect in 2002; however, this was the first flight since November 2017 because of an "impasse that prevented standard Treaty flights for all states parties throughout 2018," Davis said. The impasse preventing these flights was related to disagreements between Russia and Georgia, according to the Pentagon.

In addition, the US had declined to certify the Russian version of the treaty aircraft, a Tu-214, until it was inspected by US and allied partners last fall, according to the State Department. —Brian Everstine



Photo: ULA

A United Launch Alliance Delta IV Heavy rocket carrying an NRO payload lifts off on Jan. 19.

■ ULA, SpaceX Split Latest Launch Services Contract Awards

The Air Force has tapped United Launch Services and SpaceX to provide launch services for six national security space missions, together worth nearly \$740 million, under the Evolved Expendable Launch Vehicle program.

ULS, the Colorado-based subsidiary of United Launch Alliance, won a larger share of funding at \$441.8 million for up to three missions: the secretive "Silent Barker" space situational awareness program, Lockheed Martin's fifth Space-Based Infrared Surveillance Geosynchronous Earth Orbit satellite, as well as an option to launch SBIRS GEO-6.

California-based SpaceX received \$297 million to launch two classified National Reconnaissance Office payloads known as NROL-85 and NROL-87, as well as AFSPC-44, an Air Force Space Command satellite.

EELV, which starting in March will be known as the National Security Space Launch program thanks to a recent legislative tweak, aims to increase competition among US launch providers to drive down the cost of putting defense and intelligence systems on orbit. The Air Force's Space and Missile Systems Center received two offers for each set of contracts it awarded.

The missions are expected to launch from Cape Canaveral AFS, Fla., and Vandenberg AFB, Calif., between February 2021 and March 2022.

AFSPC-44 should be ready to launch by February 2021, while NROL-85 and -87 are expected to enter space by December 2021. Silent Barker is slated for launch by March 2022. SBIRS GEO-5 launch is planned for March 2021, ULA said, and SMC noted SBIRS GEO-6 may launch in Fiscal 2022.

This is the sixth competition held under Phase 1A of the EELV program. —Rachel S. Cohen

■ The War on Terrorism Casualties:

As of March 11, a total of 64 Americans had died in Operation Freedom's Sentinel in Afghanistan, and 75 Americans had died in Operation Inherent Resolve in Iraq, Syria, and other locations.

The total includes 134 troops and five Department of Defense civilians. Of these deaths, 64 were killed in action with the enemy while 75 died in noncombat incidents.

There have been 374 troops wounded in action during OFS and 77 troops in OIR.



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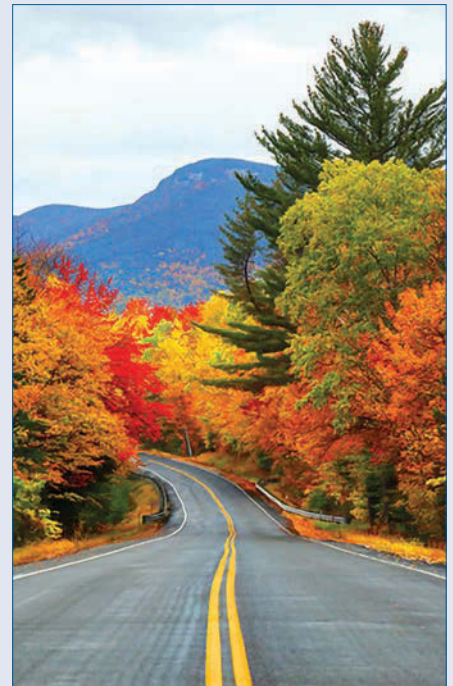
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Photo: Mike Tsukamoto/staff

MSgt. Jonathan Maas, of the 52nd Fighter Wing at Spangdahlem AB, Germany, won the 2019 Spark Tank competition at the Air Force Association's 2019 Air Warfare Symposium with a prototype power pack for the Joint Chemical Agent Detector. The unit includes a solar collector and battery backup instead of AA batteries to power the detectors. By winning, he'll now get funding to bring the idea to life.



Photo: Maj. Wayne Capps

When members of the **315th Airlift Wing** at JB Charleston, S.C., touched down in Cúcuta, Colombia, they had a surprise. Flying in on a C-17 loaded with humanitarian relief supplies for starving Venezuelans, they were greeted by Colombia President Iván Duque Márquez and Vice President Marta Lucía Ramírez. "Today, you may have helped changed the world," Duque Márquez told the crew. "You are helping more people than you could possibly know."



Photo: A1C Caleb Nunez

Florida Air National Guardsman **A1C Peejay Jack**, a vehicle maintainer with the 290th Joint Communications Support Squadron, interrupted his daily commute to help rescue a man from a burning vehicle. "I did what any other human being would have done," said Jack, who earned an Airman's Medal for his actions. "God put me in a position to help a man in need so he could get back to his family."

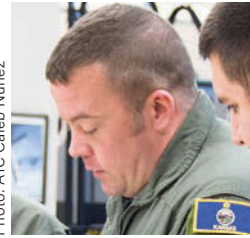


Photo: Amm. Emily Amyotte

A Kansas Air National Guardsman found a better way to train KC-135 aircrews. 190th Operations Group Aircrew Training NCO-in-charge **MSgt. Nathan Neidhardt** built a plywood simulator to help airmen train on loading techniques when aircraft aren't available. "While we were on the jet trying to train, the aircrew had to sit and twiddle their thumbs," Neidhardt said. Three builders, one weekend, and less than \$3,000 solved the problem.



Screenshot: USAF video

F-35A Lightning II Demonstration Team lead **TSgt. Michael Couture** took his re-enlistment oath with the team's commander, Capt. Andrew "Dojo" Olson, while flying in the rear seat of an F-16. Couture, a Burlington, Vt., native, previously worked as an F-16C maintainer and an F-35A dedicated crew chief. He is one of nine enlisted members supporting the team, part of the 56th Fighter Wing at Luke AFB, Ariz.



Photo: Georgia ANG

1st Lt. Andrea Lewis, first made history by becoming Georgia Air National Guard's first black female pilot in April 2017. Soon, she'll be the first to deploy, as well. The E-8C Joint STARS copilot, assigned to the 116th Air Control Wing at Robins AFB, Ga., fell in love with flying after beginning her career as an Air Force Reserve flight attendant.



Photo: USAF

Twenty Air Force Special Operations Command airmen on Feb. 22 began an 11-day, 830-mile ruck from JBSA-Lackland, Texas, to Hurlburt Field, Fla., in memory of the late combat controller **SSgt. Dylan Elchin** and the 19 other special tactics airmen killed in combat since Sept. 11, 2001. The march is the fifth such observance since 2009.



Photo: USAF

A1C Justen Garrido Guiffreda, 18, an electrical and environmental systems apprentice with the 605th Aircraft Maintenance Squadron, might be just another teenage Air Force recruit—except that his father enlisted on the same day as he did. "If it is something you always wanted to do, just go for it," said his father, **A1C Moises Garrido**, an aerospace ground equipment apprentice with the 19th Maintenance Squadron. "It's never too late to chase your dreams."



Photo: Phillip Lindsay via Twitter

Fans raised nearly \$5,000 to send Denver Broncos rookie running back Phillip Lindsay to the Pro Bowl, but the undrafted star gave it to someone more needy: Air Force vet **Les Thomas**, whose battle with kidney disease had him facing eviction. Inspired by a news story on TV, Lindsay donated the money and tweeted out a link to Thomas' GoFundMe page. By press time, he'd helped raise \$20,000 of Thomas' \$25,000 fundraising goal.



Photo: SrA. Stefan Alvarez

TSgt. Gregory Gauntt joined the Air Force after his parents refused to support his dream of becoming a professional wrestler. Thirteen years later, he does both. By day, Gauntt manages fuels knowledge operations for the 8th Logistics Readiness Squadron at Kunsan AB, South Korea. By night, he's Ryan Oshun, "The Jersey Devil," a South Korean pro wrestling heavyweight champ.

Know of someone we should recognize? Send nominees to afmag@afa.org

SWARMS

Why They're the Future of Warfare.

Lions and wolves attack their prey in packs, using speed and maneuver to cut off larger beasts from protective herds. Schools of fish and flocks of birds mass together to protect themselves from predators. Bees swarm to defend their hive and queen.

Military strategists have long recognized how swarming can confuse and overwhelm an enemy. As far back as 53 B.C., swarms of Parthian archers on horseback defeated Rome's larger, better-equipped forces in the Battle of Carrhae.

In the 2002 Millennium Challenge war game, retired Marine Lt. Gen. Paul Van Riper's team deployed a barrage of missiles, ships, low-flying planes, and swarms of explosive-laden kamikaze speedboats to completely disrupt a major military exercise. Within minutes, Van Riper's red team overwhelmed the carrier battle group's Aegis radar, sinking 19 ships, including the carrier and a fleet of amphibious ships. So devastating was the loss that, to save the exercise, planners paused the clock, restored the naval force, then restarted the exercise under new rules.

Now, swarming is going remote control. Just last year, the Russian-controlled Khmeimim Air Base in Syria fended off a coordinated attack by 13 drones in Syria's Latakia province. While the Russians were able to defend themselves, Russian Deputy Defense Minister Alexander Fomin accused the United States of coordinating the attack, saying, "only a technologically advanced country has access to such tools."

The Pentagon denied the claims, but whoever managed to launch the attack had clearly mastered the coordination necessary to mass forces against a stationary enemy.

Modern civilian drones are increasingly sophisticated, and civilian firms in both the US and China have demonstrated remarkable agility in operating swarm formations. At the 2018 Winter Olympics, US chipmaker Intel broke a Guinness World Re-

cord (previously held by China), launching 1,218 "Shooting Star" drones in a nighttime light display that both amazed the global audience and sent chills down the spines of anyone concerned about aircraft safety. The swarm of tiny drones flew tightly coordinated patterns, morphing from athletes participating in various Olympic sports into the iconic five-ring Olympic symbol.

That same technology could be weaponized simply by flying into the path of a jet at takeoff or by persistently disrupting airfield operations. Increasingly powerful artificial intelligence algorithms and "hive-mind mechanics" could enable fleets of micro-drones to easily overwhelm or harass enemy air operations.

As in nature, swarms can produce a collective intelligence that enables a group to move in sync to accomplish an objective.

US defense researchers are pursuing multiple programs to study and develop technology to employ and defend against swarms.

This month, *Air Force Magazine* delves into both sides of the equation. In "The Looming Swarm," News Editor Amy McCullough explains how swarming can be applied across the spectrum of warfare—from initial forays into enemy airspace in an anti-access, area-denial scenario, to using a coordinated flock of drones to map the progress of a wildfire.

Then, in "The Drone Zappers," Senior Editor Rachel Cohen reports on progress developing high-power lasers and microwave weapons to defend bases against swarming drone attacks by knocking threats out of the sky.

On both the offensive and defensive fronts, researchers agree they still have much to learn. But the potential is enormous. Investing in technology, tests, and experimentations now will help assure that the US Air Force is ready.

The Looming Swarm

Drone swarms could become a reality on the battlefield sooner than you think.



By Amy McCullough

Swarming technology could find its way to the battlefield within the next few years, at least in a limited capacity, but it will take some time to marry up the artificial intelligence and autonomy needed for a high-end fight.

“I love swarming technology, you probably knew that given the job I came from. I think it’s what future warfare looks like,” said Will Roper, the assistant secretary of the Air Force for acquisition, technology, and logistics.

Roper took over the Air Force’s top technology job in February 2018, after nearly six years at the Defense Department’s Strategic Capabilities Office, where he

“I love swarming technology, you probably knew that given the job I came from.”

—Will Roper, Air Force acquisition chief

oversaw development of the Perdix program, among other new technologies.

Perdix are expendable, micro-drones that can be pushed out the back of a variety of military aircraft and fly ahead of larger, more expensive remotely piloted aircraft or manned aircraft to conduct intelligence, surveillance, and reconnaissance missions. The Strategic Capabilities Office, in partnership with Naval Air Systems Command, tested the advanced swarming capability in 2016, launching more than 100 of the micro-drones from three F/A-18 Super Hornets over Naval Air Weapons Station China Lake, Calif.

“Due to the complex nature of combat, Perdix are not preprogrammed synchronized individuals, they are a collective organism, sharing one distributed



DARPA's Gremlins program, shown in this artist's concept, envisions launching groups of unmanned aircraft from bombers, transports, and fighters to attack targets while the host aircraft are still out of range.

Illustration: DARPA

brain for decision-making and adapting to each other like swarms in nature,” Roper said at the time. “Because every Perdix communicates and collaborates with every other Perdix, the swarm has no leader and can gracefully adapt to drones entering or exiting the team.”

But Roper told reporters in February it was a struggle to even find a range to conduct the test, saying the Defense Department must adapt its thinking to deal with such technology.

“I went to them and said, ‘I’d like to kick 100 micro-UAVs out of fighters,’ and they said, ‘Ok, tell me the flight plan for each one,’” Roper said. “‘I don’t have one. They are going to do their own thing, but I can draw a box and make sure they don’t leave that box.’ ... We have to shift from ‘you need a flight plan’ to, ‘no you need a box, you need a boundary,’ and that’s OK.”

But before swarming can move “beyond the world of science and technology,” he added, questions do need to be answered: “How do you certify it? How do you test it and evaluate it? Who owns it? Is it a weapons system? Does the platform using it own the autonomy—and swarming and collaboration—or is there a program for swarming and collaboration that plugs that autonomy into all sorts of platforms?”

Air Force test and evaluation, operational testing, and air-worthiness experts will have to get creative to nail down the answers.

Scott Wierzbowski, a program manager with the Defense Advanced Research Projects Agency’s Tactical Technology Office, said researchers are still learning how swarms might operate and how to incorporate AI algorithms and cooperative autonomy. But he also said

Expendable micro-drones

The Perdix micro-drones are capable of low-altitude intelligence, surveillance, and reconnaissance and other short-term missions. They can be air, sea, or ground-launched and operate in both small and large swarms to perform their missions.



Source: Strategic Capabilities Office, Perdix fact sheet

swarming, in a basic sense, can still be an effective tool for the warfighter today.

GOOD GREMLINS

Swarming has applications across the full spectrum of warfare. On the high-end, consider an anti-access, area-denial (A2/AD) environment where peer adversaries have deployed multiple integrated air defense systems, making it extremely difficult to penetrate the airspace. Swarms of small, affordable drones could saturate the threat, reducing the risk to manned and more expensive remotely piloted aircraft.

The low-cost drones would share sensor data and work together, Wierzbanski said, but “if they get shot down, it’s OK.” Losing a drone would be an acceptable cost.

“We really believe that some of these threat areas are going to be extremely dangerous, and we know we need to get close enough to be able to do certain things within those regions.”

Now, consider a clandestine operation in a permissive environment, where a smaller swarm of two to four unmanned aircraft could be launched out the back of a C-130, deploying sensors or widening the path for the C-130—or some other aircraft—to conduct its mission.

In that scenario, “they don’t need the Reapers, or Global Hawks, or the fighters coming in providing that suppression of enemy air defense,” Wierzbanski said. “They can actually keep it all internal to their own system and be able to do things in maybe a simpler matter, that’s more concise, and in line with what the squadron wants to do. That scalability among different complexities of war is one of the key advantages you get out of this system that you wouldn’t necessarily get out of a legacy-type system.”

Last April, DARPA awarded Dynetics Inc., a 21-month, \$38.6 million contract to fund Phase 3 of its Gremlins program. Overseen by Wierzbanski, Gremlins focuses on the enabling technologies needed to support such disaggregated operations in the future. Specifically, Gremlins sets out to prove that multiple air vehicles can be safely launched and recovered from a C-130 operating far outside of enemy defenses.

After the Gremlins complete their preprogrammed mission, the C-130 would retrieve the air vehicles using a horizontal docking station similar to an air refueling receptacle. Instead of a basket, the dock mechanism would mechanically lock onto the Gremlin to support it, said Tim Keeter, Dynetics chief engineer and deputy program manager for the Gremlins program.

SPECS

PROPELLERS: 2.6 inches

BODY: 6.5 inches

WINGSPAN: 11.8 inches

WEIGHT: 290 grams (0.63 pounds)

ENDURANCE: More than 20 minutes

AIR SPEED: 40 to 60 knots or more

BRAIN: Perdix share a distributed brain for decision-making and adapt to each other and their environment. Every Perdix communicates and collaborates with each other, but the swarm has no leader and can adapt to changes in drone numbers.

The Gremlins air vehicles themselves are about 14-feet long and weigh about 1,600 pounds when fully fueled. That’s much larger than Roper’s Perdix micro-drones and about the size, Wierzbanski said, of current cruise missiles.

In Phase 3, DARPA wants Dynetics to recover four Gremlins within 30 minutes in its first big demonstration, slated for January 2020. Longer term, a single C-130 could recover up to 16 of such vehicles, depending on operational requirements. And conceptually, Gremlins could also be launched from F-16s, B-52s, and other aircraft with little modification to the aircraft. That could significantly alter the number of systems in a swarm.

In early February, the team conducted flight tests with its docking station at China Lake, though without an actual Gremlin air vehicle. By early April, Dynetics plans to test the Gremlin’s avionics in a piloted Calspan Learjet.

“It’s like taking the brains of our air vehicle and hosting them on their Learjet,” Keeter said. “It will fly their Learjet around and, of course, if there is any issue or any concerns the human can take over.”

The first Gremlins flight will follow this summer, proving its capability before it is put to work near manned aircraft.

Unlike Roper’s Perdix, Gremlins will not incorporate artificial intelligence or the autonomous behaviors—at least not yet.

Wierzbanski oversees another program at DARPA that does just that, however. The Collaborative Operations in a Denied Environment, or CODE, program looks at “the autonomy necessary for groups of UAVs to work together, where the operator is more at the strategist level or an oversight level,” he said. “He’s just more providing commander’s intent and the system is able to figure out from that commander’s intent what the system is able to do.”

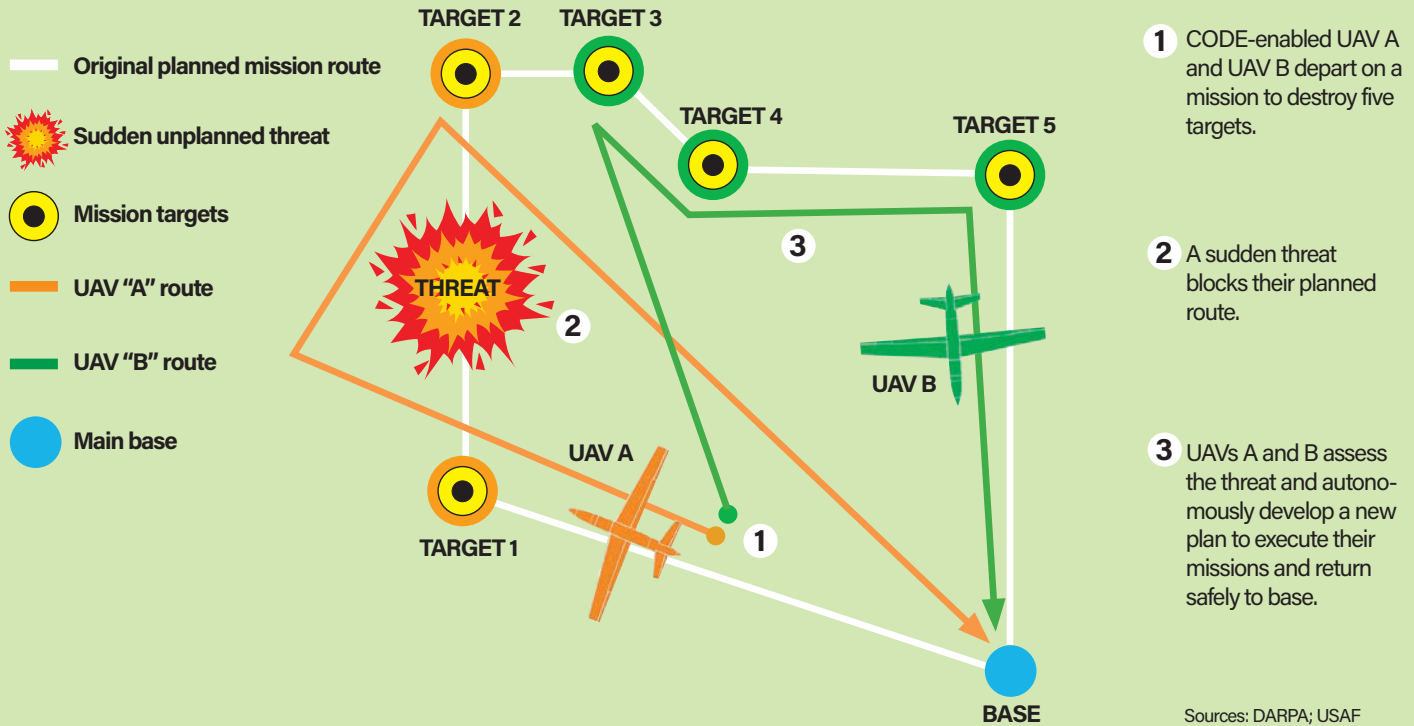
DARPA tested the CODE UAV’s ability to adapt and respond to unexpected threats in an A2/AD environment late last year at the Yuma Proving Ground in Arizona. The air vehicles initially were able to interact with a supervisory mission commander, but when communications were degraded or denied, the vehicles proved they could accomplish the mission without live human direction.

“The demonstrated behaviors are the building blocks for an autonomous team that can collaborate and adjust to mission requirements and a changing environment,” said Wierzbanski in a DARPA release.

DARPA will continue to manage the CODE program until this spring, when it will transition to the Naval Air Systems Command. However, Wierzbanski said if he were “king

Changing on the fly

DARPA's Collaborative Operations in Denied Environment (CODE) program will enable multiple CODE-equipped unmanned aircraft to collaboratively sense, adapt, and respond to unexpected threats and new targets. The systems can share information, plan and allocate mission objectives, make coordinated tactical decisions, and react in a high-threat environment.



Sources: DARPA; USAF

Illustration: Mike Tsukamoto/staff

for a day," he'd love to bring the Gremlins and CODE programs together to see what could be accomplished.

"Because I have both of them, I'm able to work the advantages of one system on the other," he explained. "Given that these programs are scoped separately, it's talking to the services and saying, 'Hey, listen, ... it would be really, really good if we integrated these two programs into a neat demonstration or an experiment where we take the best of breed, put them together, and let's go see what type of missions we can actually do.'"

Wierzbanski said he has weekly conversations with DOD stakeholders and has received some interest, but so far, interest has not produced funding.

HUMANITARIAN ASSISTANCE

Swarming also could be useful in humanitarian operations, like disaster relief.

The Air Force Research Laboratory at Wright-Patterson AFB, Ohio, is working with the Wright Brothers Institute and the University of Dayton Research Institute on the "Swarm and Search AI Challenge," which will run concurrently with a similar competition in the United Kingdom.

The challenge asks participants to figure out how to plan and control simulated swarms of small, unmanned aerial vehicles as they map a wildfire. Teams must use the same UAV design and sensor set, which is based on an AFRL platform, as well as artificial intelligence technology, to come up with the most effective way to accomplish the mission. The UK Forestry Service will post videos for all the teams to outline the scope of the problem, said Mick Hitchcock, senior technology adviser for AFRL small business, in an interview with *Air Force Magazine*.

"The challenge is focused on a humanitarian mission,

but in reality, the learning applies very well to ... Air Force interests," Hitchcock said.

The idea came about last spring when representatives from the UK's Defence Science and Technology Laboratory visited the Wright Brothers Institute in Ohio. At the time, wildfires were ravaging California, and another wildfire had just caused significant damage in the UK. By making it a humanitarian challenge, the two labs were able to reach out to nontraditional small businesses and universities "who may not want to play on a military mission," Hitchcock said.

The first scenario is a basic test to get the teams familiar with the software. The scenarios will get progressively more difficult as the challenge goes on, culminating in a "final showdown" on March 29-31.

Hitchcock said the UK is "doing a lot of work in this arena," and the US has "already learned a lot from the interaction."

THE AI COMPONENT

Roper acknowledged the Air Force "needs to do more with AI," as well as the challenge posed by matching legacy acquisition rules to develop software and network technology that crosses multiple systems.

To date, maintenance has proven to be "fertile ground" for operationalizing AI, but the stakes get higher with systems affecting missions and lives, Roper said.

Still, researchers are making progress.

"This is no longer something that's 10 to 15 years down the road," Wierzbanski said. "This is something that can be implemented within the next year or two years and actually be used with our current weapons system, or derivatives of our current weapons system." ❖

The Drone Zappers

Directed-energy weapons emerge as a key to base defense—and possibly more.

By Rachel S. Cohen


The Air Force's deployed security forces will soon be able to knock down small drones at the click of a button using lasers and microwave weapons, marking the service's first test of directed-energy weapons in theater.

Two Raytheon systems—a laser and a high-power microwave—will deploy to an undisclosed overseas base this spring to defend them from prying eyes and potential mischief posed by commercial drones outfitted with cameras and even weapons, according to Michael Jirjis, who oversees directed-energy initiatives in the Air Force's Strategic Development, Planning, and Experimentation Office (SDPE).

The threat is so pressing, Jirjis said, that Air Force Vice Chief of Staff Gen. Stephen W. Wilson wants to shift funds from other directed-energy programs to solve the base-defense problem faster.

"Right now, we need to put capability in the field and see what's being offered," Jirjis said. "Eventually we'd like to move these systems to a low-rate initial production, but there's a lot of learning that still needs to be done before we get there."

The new weapons destroy or disorient unmanned aircraft. Lasers focus an invisible heat ray on the aircraft to melt its body. Microwaves, on the other hand, can combat multiple drones at once, and either reroute or disable them so they drop out of the sky. Eventually, both could be incorporated into a single system that could use microwaves to deter aircraft or swarms of UAVs and lasers to destroy individual, persistent threats.



SrA. Johnny Hillary takes aim through a holographic scope on a drone defender rifle at Moody AFB, Ga.

"Right now, we need to put capability in the field and see what's being offered;"

—Michael Jirjis, chief of Air Force Directed-Energy Experimentation

Operationally testing the weapons in a combat zone will help researchers gather data on performance and maintenance requirements before the Air Force commits to an acquisition program. Jirjis said the assessment will last nine months to a year.

While it's unclear where the next round of experimentation will take place, Air Force officials at home and abroad have voiced concerns about the threat. Then-SDPE Director Thomas Lockhart recalled in a recent Defense Department video how small drones were constantly surveilling a base he visited in Afghanistan in 2017. "We had a lot of unmanned systems sitting over and watching everything we do," he said. "Our airmen would like to not be monitored 24/7, and this will push this back so they won't have that monitoring capability."

US Central Command did not respond to questions on how often drones threaten area bases.

TEST DRIVE

Raytheon's systems were the only two that qualified for an initial Air Force experiment at the Army's



Photo: Ann, Eugene Oliver

White Sands Missile Range in New Mexico last fall. The test sought to explore the policy, tactics, training, and more of what's needed to make them part of everyday operations.

Young airmen from three bases got a crash course on directed energy, then headed to hands-on training with the systems, which use an Xbox-style controller to direct the laser and a joystick to operate the microwave weapon.

Qualified systems were asked to identify, target, and track drones weighing 55 pounds or less and flying 500 meters away and be able to engage aircraft from 300 meters away and destroy them within 100 meters. Each system had to counter five to 10 unmanned aerial systems within a minute.

"These were unscripted tests," Jirjis said. "[Operators] didn't really know what threats were coming at them or the number, when, or the direction. We wanted them to be able to work through the entire process of detecting, ID'ing, tracking, and trying to mitigate Group 1 UASs (unmanned aircraft systems)."

A Pentagon video published in December 2018 shows a quadcopter, aloft in the cloudless, blue New Mexico sky, start to glow white-hot as a laser focuses its energy on the craft. After a pause, it tumbles to the ground in a cascade of sparks.

Another drone, confused by a microwave, momentarily wobbles before plummeting.

"At first, you'd have one drone or two drones flying at different angles," said Evan Hunt, Raytheon's high-energy laser business development director, in an interview. "Eventually they ramped that up to be maybe two or three drones at a time. So it wasn't a full, deep swarm yet, although certainly I think we'll graduate to more intense swarming simulations."

Hunt said the tests proved a single airman could see and attack a drone with the laser within 30 seconds. In the future, he expects it may take as little as 10 seconds to wield such power.

One goal of the testing was to "oversaturate" the operators and find their limits, Jirjis said. While participants were flexible, and both weapons effectively shot down drones, individuals and systems could only handle so many threats at once. He declined to describe those limits.

"It highlights the need for machine learning or artificial intelligence to be able to help that detect-ID-track portion of it," he said. "When you start to look at one-on-one scenarios with a UAS versus swarming scenarios, it becomes a very challenging environment."

While systems that can handle a few drones at a time may



Screenshot from White Sands Missile Range video

Michael Jirjis, chief of directed-energy experimentation at the Strategic Development, Planning, and Experimentation Office, said the Air Force is developing operating concepts and techniques that could invoke using both lasers and microwave weapons to complement unmanned aircraft.

work in the short term, how the Air Force would ramp up or link its weapons together to fight larger swarms remains to be seen.

Jirjis said the Air Force still hopes to learn more about how high-power microwaves affect a drone's electronics. He also wants to see improvements in the weapons' command and control functions that would combine weapons into a true kill chain.

The process of detecting a UAS on radar, assessing it with an electro-optical/infrared sensor, asking for permission to fire, targeting, and attacking should move faster, Jirjis noted. Using artificial intelligence could help at each step, particularly by identifying whether a looming object is a friend or foe.

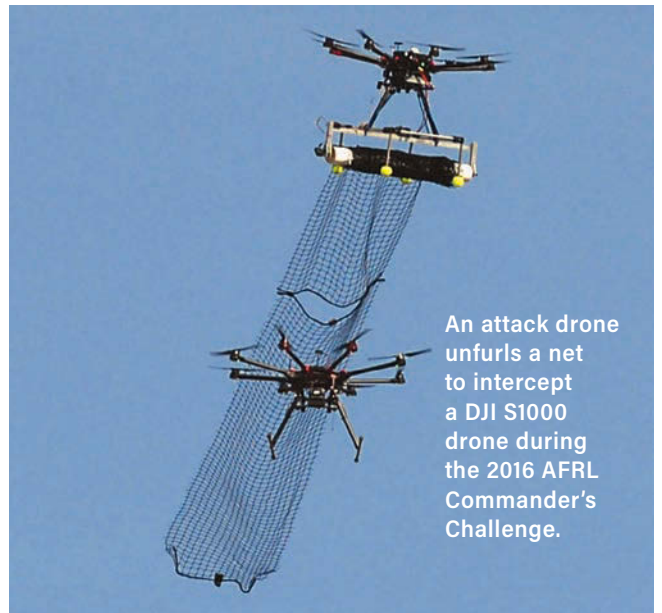
During the tests, security forces were not allowed to fire at approaching aircraft when satellites were passing overhead, forcing the researchers to schedule times when operators could actually engage targets without threatening satellites orbiting above. When satellites were present, participants were limited to practicing detecting, identifying and tracking targets, but could not attack.

That wouldn't necessarily be a problem when the systems are deployed overseas, Jirjis said.

"In a real-life scenario, the operator or the commander that's in charge will have to take on that risk if they want to assume it," he said. "The risk [of] actually damaging something that's flying behind it, [such as] a satellite, is very, very low."

The experiment featured one of DOD's earliest—if not first—attempts to combine lasers and microwaves into a single weapon.

"It provided some unique effects, and there's definitely some exploration that needs to occur on joint effects for when you're trying to take [drones] down," according to Jirjis. "If one aspect of a high-power microwave system is to stop the movement of a UAS, it may provide the laser



An attack drone unfurls a net to intercept a DJI S1000 drone during the 2016 AFRL Commander's Challenge.

Photo: Wesley Farnsworth/USAF

system a better shot, for example."

Hunt believes security forces personnel are probably the right candidates to take on the counter-UAS job, requiring only about two weeks of additional training.

"It fits nicely in their wheelhouse because they need to maintain situational awareness of the entire airfield, and they are charged with protecting the ramp and the assets on the ramp," Hunt said.

Don Sullivan, a chief technologist who works with high-power microwaves at Raytheon, added that if airmen already know one directed-energy system, they could likely learn how to use the other within a day.

Raytheon wants to build a simulator so airmen can train without the restrictions of a military test range, according to Hunt.

"There's no reason that ... we couldn't do 99 percent of

Lasers vs. drones

A Raytheon laser weapon (1) identifies (2), engages (3), and destroys (4) a small UAV during a fall 2018 test at White Sands Missile Range in New Mexico. The laser heats the fuselage and burns up the UAV's electronics. Airmen trained at White Sands with Xbox-style controllers (5) to direct a laser weapon.

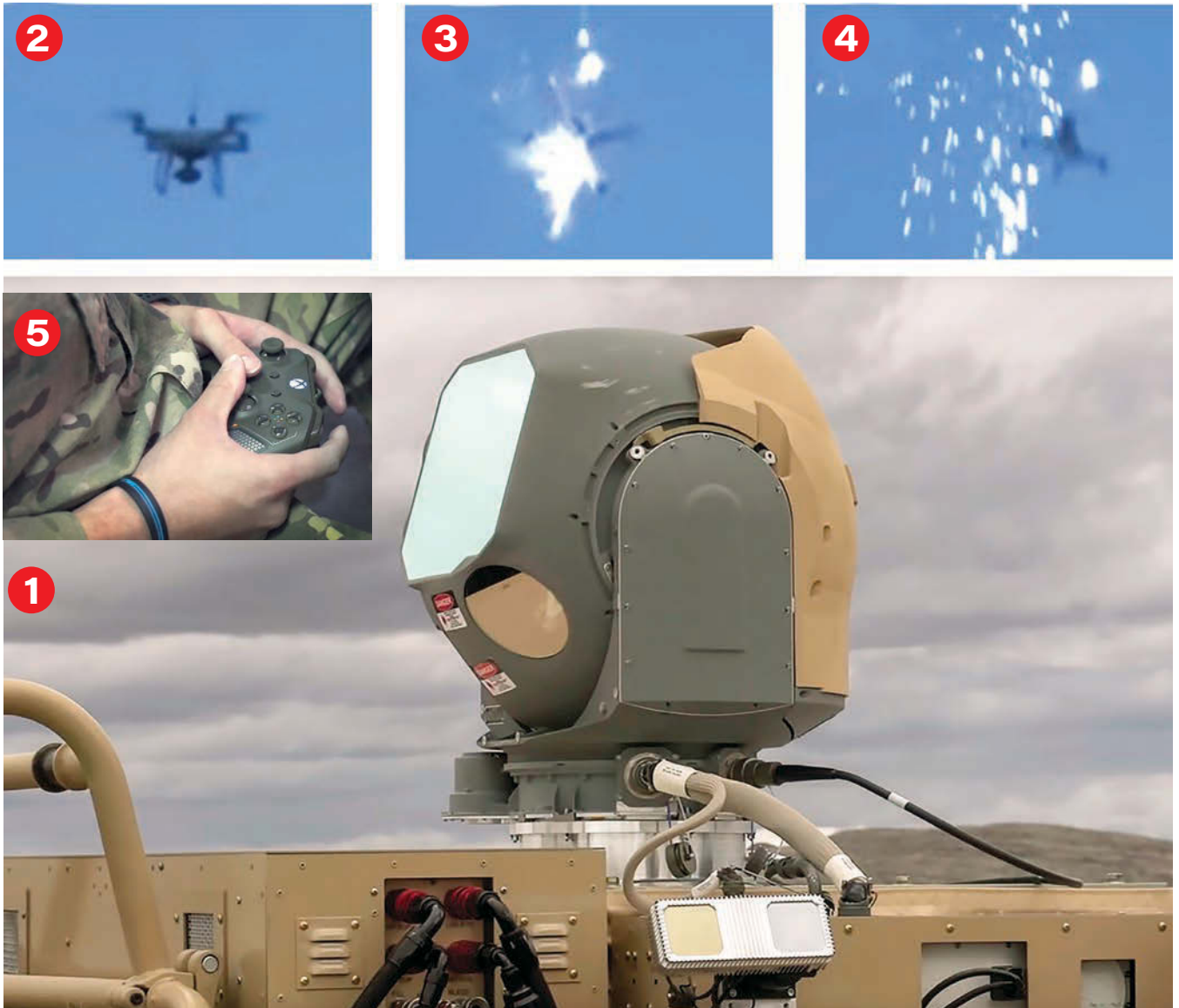


Photo: White Sands Missile Range; screenshots from White Sands Missile Range video; White Sands Missile Range

our training via simulator and then maybe just check an airman out for his final qualification run at the range,” Hunt said. “If this idea matures, we’ll probably offer that to the Air Force as part of our training package.”

NEXT STEPS

Directed-energy weapons are part of an overall counter-UAS plan the Air Force wants to institute at all overseas bases. A “large number” of facilities outside the continental US need a fix as soon as possible, and a “handful” are candidates for lasers or microwaves, Jirjis said.

The weapons would be used in much the same way overseas as they were in testing, although the Air Force will create rules of engagement for each base.

While overseas facilities need more immediate protection, the Air Force is also weighing options for domestic UAS defenses. US Strategic Command chief Gen. John E. Hyten told Congress as far back as 2017 that he had issued classified guidance on how forces should respond if a drone approaches a military site. But the prospect of handing them

directed energy is more complicated.

“The [directed-energy] community is still working through how that works for supporting systems [at US bases],” Jirjis said. “There is a difference between a forward-operating base where a commander has purview on protecting his base and his forces, whereas CONUS, there’s a lot more that needs to be taken into consideration.”

In October, the Air Force plans to latch onto the Army’s annual Maneuver Fires Integrated Experiment, known as MFIEX, to consider more kinetic, sensor, and radar options. Security forces will again push those technologies’ limits, as in the White Sands tests last fall.

MFIEX “is going to focus on the systems that show up and their connectivity into a command and control [system] that we would use,” Jirjis said. “Once we have those data points ... we’ll have a good amount of information that could feed into a low-rate initial production.”

Based on the results of all three experiments, the Air Force Life Cycle Management Center (AFLCMC) will then decide which company’s weapons best meet the service’s

An artist's concept of Raytheon's vehicle-mounted, high-energy laser repelling a drone swarm attack.



Illustration: Raytheon

needs. The Air Force hopes to begin buying directed-energy systems in the next two years.

Raytheon officials declined to say how much each weapon system costs.

To date, the Air Force has taken a largely piecemeal approach to UAS defense, relying on nets, a variety of guns, electronic jamming, and improvisation while waiting for a long-term program. AFLCMC Digital Program Executive Officer Steven D. Wert advocates for a counter-UAS strategy comprised of multiple new technologies as they become available, rather than waiting for a single, fully mature solution.

A newly formed, congressionally funded office meant to bridge the gap between directed-energy research and acquisition aims to bring disparate programs under one umbrella, Jirjis stated. That group will partner with others to develop directed-energy weapons for a range of missions, both offensive and defensive.

Whatever the Air Force buys will need to connect to the other services' counter-UAS systems and may land in joint operating locations. Jirjis noted the Air Force is coordinating with the Office of the Secretary of Defense on prototyping programs that gradually add in new capabilities.

"Interoperability is a very important aspect to the systems we are considering," Jirjis said. "We can provide capability now that addresses immediate need and work with our service partners for the best-of-breed option in the long-term acquisition process."

THE PATH FORWARD

It's been a busy few years in directed-energy research.

The Air Force's flagship directed-energy program, the Self-Protect High-Energy Laser Demonstrator (SHiELD) pod slated to fly on Boeing's F-15 in the 2020s, began ground tests last year. Air Force Special Operations Command is prototyping a laser weapon for its AC-130J gunship. Officials from across the service have chatted with the Air Force Research Laboratory about how they could tap into the evolving technology, too.

The Air Force put the final touches on a directed-energy flight plan in 2017, spurring new investments in base defense, precision strike, and aircraft protection. In addition

to the higher-profile efforts, the service will experiment with directed energy to shoot down cruise missiles and to fire microwaves from a launched weapon. It has considered installing lasers and microwave weapons on tankers, cargo planes, and bombers.

It also canceled an accelerated, flexible weapon prototype designed to defend bases and aircraft, on land or in flight. Some funds from that program will instead boost the base-defense initiative, which is seen as the lowest-hanging fruit, Jirjis said.

"When I look at the overall picture and what was approved just recently, it's not that we are scrapping our airborne prototype portions," Jirjis said. Rather, it's about focusing attention "toward prototypes and transitions that are for immediate need right now and ... [skipping] over intermediate phases and look[ing] at prototypes that will be ready."

Inside Defense reported in March 2018 the Air Force wanted to spend nearly \$1.3 billion on directed-energy research, development, and prototyping from fiscal 2019 to fiscal 2024. Richard J. Joseph, the service's chief scientist, told the publication last summer the military should try not to stretch those resources too thin. Doing so risks derailing programs, he said.

Jirjis told *Air Force Magazine* those same concerns are in play with base defense. The Air Force is still spending a "fair amount" to see how high-demand intelligence, surveillance, reconnaissance, electronic warfare, and tanker aircraft could carry lasers and microwaves, he said.

Senior leaders plan to gather in the spring to further hash out their next steps, according to Jirjis.

Lessons learned from the base-defense experiment will ripple through other weapons programs similar to the SHiELD as they come to fruition. By getting a better idea of the policies and procedures this future tech requires, the Air Force could hand them off to warfighters faster.

"Operators will have to sit in that seat [and] understand how to use these systems in the right environment," Jirjis said. The Air Force must also further define requirements and develop doctrine and policy for the use of directed-energy weapons. Both will take time. But as with any emerging technology, the opportunities and possibilities aren't always clear until operators get to try it out. ✪

Climbing Out of the Munitions Hole

To fix the bomb shortage, USAF is making record buys, while the Pentagon moves to preserve component vendors.



SSgt. Jeric Hernandez inspects a fresh shipment of bombs at Ramstein AB, Germany. For years, allies have counted on drawing from US stocks instead of investing in their own inventory.

Photo: SFA, Joshua Magbanua

By John A. Tirpak

The Air Force is making progress filling a four-year-long shortage of precision guided munitions—but will keep struggling with shortages as long as it keeps using them at a furious pace. Prime contractors, meanwhile, are “maxed out” in munitions production, and the Pentagon is working to ensure that the makers of key weapon components don’t disappear from the industrial landscape.

“We’re very focused on munitions capacity, because we’ve been dropping a lot of weapons,” Air Force acquisition chief Will Roper said in February. The Air Force has dropped “over 70,000 weapons on ISIS, ... and we need to be able to buy back many of our weapons at scale.”

The limiting factor, he said, is “the capacity to make them.”

The key weapons in the fight are the satellite-guided Joint Direct Attack Munition, or JDAM, which

“We’re very focused on munitions capacity, we’ve been dropping a lot of weapons.”

—Air Force acquisition chief Will Roper

comes in variants ranging from 500 pounds up to 2,000 pounds; the AGM-114 Hellfire laser guided missile, which equips Army helicopters as well as Air Force MQ-9 Reaper remotely piloted aircraft; the Small Diameter Bomb, which is a 250-pound satellite-guided munition; and Advanced Precision Kill Weapon System, or APKWS, a seeker head for Hydra rockets carried by helicopters and F-16 fighters. These weapons have been used the most in the war against ISIS since the rules of engagement demand extreme precision: ISIS targets are usually mixed in among civilians, and the coalition has made minimizing civilian deaths a top priority.

Commanders have been loathe to use nonprecision weapons against ISIS because an errant bomb that kills civilians can have instant, strategic implications for international support of the anti-ISIS effort.

A week prior to Roper’s remarks, his uniformed deputy, Lt. Gen. Arnold W. Bunch Jr., told an Air Force Association audience on Capitol Hill that, “we have ramped up JDAM production to 45,000 a year,

SSgt. Travis Gaskins prepares to load a Joint Direct Attack Munition (JDAM) onto an F-16 at an undisclosed location in Southwest Asia. To meet rising demand, production of the guided GBU-54s has increased to 45,000 per year.



Photo: MSgt. Caycee Watson/ANG

now,” describing it as a “Herculean effort” with Boeing, the maker of the weapon.

Moreover, “we are working with the Army to max out the Hellfire production,” Bunch noted. The number being purchased “we’ve ramped up ... significantly above what it’s ever been.” Lockheed Martin makes the Hellfire.

Production of the Small Diameter Bomb I, also made by Boeing, is up to 8,000 a year, “way more than we ever thought we would buy,” according to Bunch, and production of APKWS has also “dramatically gone up.” The Air Force is “working with the Navy to drive that up and it’s higher than it’s ever been.” The APKWS is made by BAE Systems.

The Air Force is not the only customer for these weapons. Its 2020 budget request provides a glimpse of the service’s share of that production:

- **JDAM.** USAF is seeking funds to buy 37,000, up 1,000 units from 2019.

- **Small Diameter Bomb.** 7,078, up 23 percent from 2019.

- **AGM-114 Hellfire.** 3,859, up three percent from 2019.

- **Small Diameter Bomb II.** 430, up 19 percent from 2019.

Four years after then-Chief of Staff Gen. Mark A. Welsh III warned that worldwide munitions reserves were getting dangerously low, concern about shortages remains.

Former Air Force Deputy Undersecretary for International Affairs Heidi H. Grant told reporters in December that at least one ally had admitted that rather than maintain its own stockpile, “it was their strategy to draw ... on our stocks” in the event of a conflict. Now the director of the Defense Technology Security Administration, Grant said she advised allies that the Air Force had drawn down its inventories too low to be able to lend munitions in future conflicts, telling them, “you guys need to start putting in your orders.”

The fiscal 2019 budget request set out a plan to rebuild stockpiles across the next five years. An Air Force spokeswoman said the buy rates on “preferred munitions” would

continue across the Future Years Defense Program “to replenish combat expenditures and build munitions inventories to meet future strategic needs.” Requirements would be revisited “as conditions change,” she said, adding that “payback” of ally borrowed munitions is expected by Sept. 30, when the fiscal year ends.

Roper, however, suggested that plan may be in jeopardy.

“Munitions ... often become a bill payer in program reviews,” he said. Budgeters think “you just buy fewer,” Roper explained, and while “that may seem like an easy choice on a tally sheet ... if you’re an acquisition person, and you take the buy lower, you just lost economy of scale—you just made it harder for your vendor to forecast ahead.”

Predictable orders mean contractors can buy materials and plan for labor requirements more economically, holding prices down, while uncertainty forces prices up.

“I wish we would ... just stabilize the munitions we buy each year and not make them bill payers,” Roper said, “and allow our acquisition professionals to talk with their industry partners about five-year buy[s] of components, five-year build plans, and not get into perturbative schedules.”

Echoing the point, Bunch told *Air Force Magazine*, “I want stability for industry.”

He’d also like to see stability for the Air Force. Asked if the munitions deficits could be remedied within five years, Bunch was noncommittal: “The way we’re dropping them, I can’t give you a number.”

Bunch said that the weapons “borrowed” from the US have largely been paid back in-kind, but allies have yet to rebuild stockpiles.

“We’re working with them,” he said, and urging them—“Don’t wait. Buy now.”

During the 1980s—the last time the US faced “great power competition”—the Pentagon invested to ensure weapons production could surge in case of a major conflict. For radars,

SSgt. Ryan Pritt oversees the lifting of a training GBU-10 bomb at Aviano AB, Italy, in February.



Photo: SrA. Kevin Sommer Giron

jet engines, and especially munitions, the Pentagon qualified a second production source and held annual competitions between the suppliers. The winning bid earned the lion's share of production, while the loser still got enough orders to keep the line alive.

Might the Air Force return to that approach? "I always like the idea of having competition," Roper said. "We've got some thinking to do on that."

But an industry official said those competitions don't come without cost.

"There's the cost of setting up a second production line, and that's a big investment," he said. "You really have to know you're going to be turning out a lot of whatever it is—bombs, missiles, whatnot—and for a pretty long period of time. ... Budgets typically don't allow for that." That extra investment could easily negate potential savings from ongoing competition, he said, suggesting that's "probably one of the reasons" the Air Force now just presses suppliers to add shifts and capacity when it needs more production.

A second complicating factor is intellectual property. "You're taking someone's proprietary product and handing it over to their competitor, with all the drawings and blueprints," he said. "That's not something most companies want to do." Intellectual property is a very sensitive subject, he noted, and "no one wants to fund their archrival's R&D."

CRITICAL SUPPLIERS

An October 2018 multi-agency report, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," called attention to the peril of relying on single sources of supply for crucial elements of defense systems. Now the Trump administration has moved to directly invest in small companies that make materials essential for bomb construction.

The administration approved up to \$250 million to reinforce the defense supply chain—particularly makers of energetic materials, precursor materials, and inert materials used in bomb-making—and companies developing advanced manufacturing techniques for bomb components.

The report called for direct investment in the sub-tiers of the industrial base where the Pentagon is dependent on

either a single supplier—or a foreign source—for critical components, suggesting the authority for such expenditures could be justified under provisions of the 1950s-era Defense Production Act.

Other areas where the US is dependent on just a single supplier include small turbine engines, helicopter gearboxes, and solid-fuel rocket motors. ❄

Next Generation Munitions

A separate Pentagon industrial base report, from May 2018, warned that the tendency of contractors to only modestly improve existing munition designs has atrophied the talent base. Design skills today "are at risk," the Pentagon's Office of Manufacturing and Industrial Base Policy concluded.

The Air Force is developing a new munition to succeed the JDAM. The lighter-weight, satellite-guided weapon will have infrared as well as satellite guidance, wings to allow it to glide and maneuver on its way to the target, and could include stealth characteristics and some kind of electronic warfare capability. A former top Air Force official said it must maneuver not only to evade pinpoint air defenses, but to pursue mobile targets.

The Air Force Association's Mitchell Institute for Aerospace Studies, in a September 2018 report, asserted that munitions technology writ large is due for a major overhaul. There is a trend toward dynamic retargeting—in which combat aircrews frequently take off without knowing the kind of target they'll be going after—while there aren't enough aircraft to refly sorties just because they weren't carrying the right weapons. Because of these trends, Mitchell argued, it's crucial to develop munitions whose blast effects can be adjusted before release.

The Air Force needs "new effects design concepts such as variable yield, adapted effects, adjustable effects, and systems of employment," the Mitchell report said.

The Air Force has not officially described any other new precision guided munitions programs to succeed its current slate of PGMs.

Pegasus Takes Flight

**Airmen Start Sizing Up
the Future of Aerial Tanking.**

A KC-46 tanker
lifts off from
Boeing's Everett,
Wash., production
facility on Jan. 25,
headed to its first
duty at McConnell
AFB, Kan.



By Brian W. Everstine

EVERETT, Wash.

The first operational KC-46s took off from their production facility in Everett, Wash., en route to McConnell AFB, Kan., accompanied by VIPs on board and bid adieu by a cover band playing inside Boeing's massive factory. Almost eight years after Boeing won the initial \$3.5 billion contract to build the next-generation tanker, and two years past the original delivery date, the Air Force had finally accepted the first KC-46 delivery.

"We're excited," said Air Mobility Command boss Gen. Maryanne Miller at the Boeing ceremony in Everett. "We can't wait to get this airplane to McConnell, and we can't wait to get after it."

Boeing plans to deliver about three aircraft per month through the end of 2019, 36 aircraft in all, with 16 more to follow in the present contract. Eventually, the Air Force plans to field 179 of the 767-based tankers, which are supposed to help phase out today's KC-10 Extender fleet.

But while the first jets made themselves at home at McConnell and Altus AFB, Okla., and as operational testing continues at Edwards AFB, Calif., the Air Force and Boeing are still figuring out how to fix three major deficiencies:

- Glare that makes the remote vision system hard to use in certain lighting conditions.
- Inadequate sensor sensitivity, which can prevent the boom operator from recognizing when the boom scrapes a receiving aircraft.
- A boom design problem that makes it difficult to refuel slower-flying A-10 aircraft, which weren't anticipated to be in service when the KC-46 came on line.

"We have 1,000 flying hours, 4,000 refueling hours."

—Air Force Secretary Heather Wilson

While the Air Force and Boeing were working through these deficiencies, a new problem at the company's production facility forced the Air Force to stop taking new tankers just weeks after the first delivery. In late February, the Air Force announced it had found foreign object debris, items such as tools or trash, an aircraft that it had already accepted. Will Roper, assistant secretary of the Air Force for acquisition, technology, and logistics, said the service needed to review Boeing's correction plans and find the root cause of the problem before accepting more of the tankers.

The problems with the aircraft's state-of-the-art refueling system could still lead to more delays and could cost Boeing tens of millions of dollars in penalties, in addition to the more than \$3.6 billion in cost overruns the company has already had to absorb.

However, none of the remaining deficiencies are showstoppers, both company and Air Force officials insist.

"We have 1,000 flying hours, 4,000 refuelings," Air Force Secretary Heather Wilson said. "We're ready to take the next step, which is to get it in the hands of the airmen and to start operational test."

The Air Force is withholding up to \$28 million per aircraft until deficiencies are corrected, funds Boeing can receive later if corrections are made in a timely manner, according to the Air Force. Multiplied across all 52 jets in the contract, the total penalty could approach \$1.5 billion.

Getting to a "yes" on delivery required negotiating a way forward on the deficiencies, and the solution was to separate the boom problem from the remote vision system, Roper said.

The boom problem was the Air Force's fault. Boeing met the stated requirement. But the require-





Photo: Brian Everstine/staff

Gen. Maryanne Miller, AMC commander, (speaking); Leanne Caret, CEO of Boeing Defense, Space, and Security; Dennis Muilenberg, Boeing CEO; and Kevin McCallister, CEO of Boeing Commercial Airplanes, celebrate the acceptance of the first KC-46s on Jan. 24 at a ceremony prior to the flight to McConnell AFB, Kan., the next day.

ment did not anticipate the need to continue to refuel A-10 Warthogs that date back to the Vietnam era.

The problem with the remote vision system, however, is a design issue, and Boeing continues to work on solutions. Under certain circumstances, the boom operator's ability to see refueling probes link up with the boom can be impaired by glare. When the sun hits the camera at certain angles, the image degrades, making it difficult for boom operators to tell if the boom is scraping a receiving aircraft.

Wilson said the system is safe and useful "as it is," and operators have developed workarounds. For example, crews cannot refuel while flying directly away from the sun.

Air Force scientists, acquisition officials, and Boeing engineers have worked for months on a measurable fix through hardware and software changes, Roper said. That team has set nine critical performance parameters to ensure the remote vision system will meet Air Force requirements. Boeing is focusing its efforts in the first half of 2019 on development to address the problem, said Mike Gibbons, Boeing's KC-46 vice president.

"We have a lot of work to do on RVS," Roper said. "There is still design work to do—hardware and software to meet those nine critical performance parameters—so we will keep a lot of technical focus on that."

The boom issue arises due to the fact that the Warthog is much lighter and flies slower than other aircraft. As a result, it is more difficult for the A-10 to disconnect after refueling.

The Air Force will design a new actuator that will be more sensitive and make it easier for the A-10 to disengage. Anticipated as a simple fix—the Air Force has had to address similar issues before—it could still take up to four years to complete, officials say.

The Air Force faces a growing need for aerial refueling that top officials say cannot be quenched by the current fleet. The "Air Force We Need" plan that Wilson shared in

the fall calls for 74 more operational Air Force squadrons, including 14 more refueling squadrons.

"Aerial refueling will be the biggest shortfall in our Mobility Air Forces," Wilson said in September.

Already, limited availability and capability affect both operations and training. Pacific Air Forces Commander Gen. Charles Q. Brown said increased tanker capacity and capability are prerequisites to gaining "the flexibility" to span the vast Pacific Theater.

"Tankers are important, not just for the day-to-day piece, but also from an operational perspective," he said.

THE FIRST TANKERS TOUCH DOWN

The first tankers, tail numbers 15-46009 and 17-46031, left Boeing's production facility on a cold and foggy morning on Jan. 25, with a KC-135 from McConnell leading the way. Air Force Chief of Staff Gen. David L. Goldfein said the arrival of the aircraft marked a "new era" of refueling for the service.

"We're a global power because of global reach," Goldfein said. "Our allies count on it, and our adversaries know it."

The Air Force picked McConnell to be the main operating base for the KC-46 in 2014 and invested \$267 million to build three new hangars, new dormitories, a control tower, and a fuselage trainer, among other facilities, according to the 22nd Air Refueling Wing. The 344th and 924th Air Refueling Squadrons will be the first units to fly the aircraft.

At Edwards, operational test crews began Phase III certifications early this year, with plans to fuel 11 aircraft types, including F-22s and F-35s. To date, KC-46s have already refueled the A-10, B-52, C-17, F-15, F-16, F/A-18, and KC-135.

TRAINING CREWS

Two weeks after the first delivery to McConnell, Air Education and Training Command kicked off its KC-46 era at

Fixing on the Fly

Eight years after Boeing won the contract to build the US Air Force's next generation tanker and nearly two years past the original delivery date, USAF finally accepted the first KC-46 delivery. However, as the jets arrive at their new bases, Boeing and the Air Force must still fix three major deficiencies.



PROBLEM: Sensors in the boom do not alert operators when the boom scrapes receiving aircraft.

SOLUTION: Update software to recognize and warn operators when scraping occurs. Boeing will pay for the fix.

PROBLEM: The refueling operator sits at a workstation at the front of the aircraft and uses cameras and sensors to guide the boom. Under certain lighting conditions, glare can compromise the remote vision system (RVS), causing operators to overcorrect when positioning the boom.

SOLUTION: Revising software to minimize effects of glare and distortion on the Rockwell Collins-designed RVS. Boeing will pay to correct this deficiency.

PROBLEM: The refueling boom's required 1,400 pounds of thrust resistance is too great for the A-10 Thunderbolt II, which requires a thrust resistance of only 650 pounds to hold the refueling probe in place.

SOLUTION: Add a new actuator to enable the A-10 to refuel. Because this is a new requirement, the Air Force will pay all costs.

Sources: Boeing; USAF

Altus AFB, Okla., accepting two of the new tankers for the service's sole Pegasus training schoolhouse.

Altus is also home to C-17 and KC-135 training and schoolhouses, which are running at full capacity as the first cadre of instructor pilots and maintainers begins training on the KC-46. Altus crews expect the KC-46s to begin flying immediately and to quickly integrate with the other aircraft.

"Rapid global mobility starts here, because we train the preponderance of mobility crew members," said Col. Eric A. Carney, the commander of the 97th Air Mobility Wing at Altus, in an interview. "The C-17 can't do training without tankers, and tankers can't do training without the C-17. So this is an ideal place to learn together. ... The KC-135 schoolhouse and the C-17 schoolhouse will make the KC-46 schoolhouse better, faster."

As soon as the tankers touched down, Altus began a two-month familiarization period, during which maintainers, aircrew flight-equipment specialists, police, fire department, and airfield-operations personnel could get used to operating with it, said Maj. Jacob Piranio, the operations flight commander at the 56th Air Refueling Squadron. This time period gave initial Boeing-trained aircrews the chance "to get comfortable" with the plane, Piranio said.

The initial pilots were selected from a small group-tryout process and came from a variety of backgrounds, including RC-135s, B-52s, E-3s, and others, he said.

The first class of boom operators went through a similar process and tryouts, followed by familiarization at Altus,

said MSgt. Jonathan Lauterbach, boom operator and non-commissioned officer in charge at the 56th ARS.

For maintenance, Altus recruited airmen from C-17, KC-135, and KC-10 backgrounds, along with FAA-certified airframe and power plant airmen, said Donnie Obreiter, the KC-46 maintenance flight chief.

New KC-46 aircrews are excited to operate on the new aircraft, they said. While it has a shorter range and lighter total fuel load than the tri-engine KC-10, it features a modern digital cockpit, enhanced situational awareness thanks to advanced sensors built into the fuselage, and it can deploy countermeasures to defend itself. It also has a radar-warning receiver. The tanker comes from the factory with Link 16, the primary data link used by Air Force and allied aircraft.

Before the tankers arrived, Altus was the home to C-5 and C-141 flight training units. The Oklahoma base was chosen because it already had viable infrastructure from its previous schoolhouses.

"We were able to mod some existing hangars, able to capitalize on some infrastructure that was already here," Carney said. New military construction included simulators, classrooms, and a fuselage trainer, some of which had been completed years before the first KC-46s touched down.

"There's a lot of excitement," Carney stated. "Everyone has been anxious to get the new aircraft here, and we've had the personnel here, and the maintainers here, and the boom operators who have been ready to get their hands on it and get their fingerprints on the plane. And now the time is coming." ❄

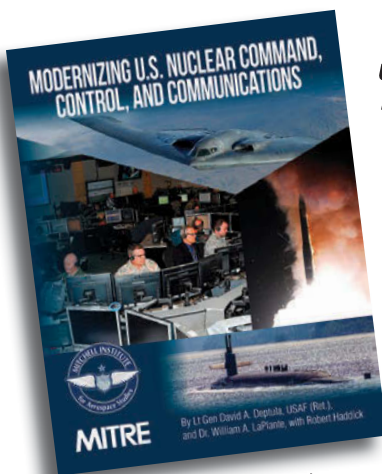
Time to Update NC3



Gen. John Hyten (r) gives a command and control update to John Bolton, national security advisor, at Offutt AFB, Neb.

Command and control—the “fifth pillar” of the nuclear enterprise—is aging fast.

By Lt. Gen. David A. Deptula, USAF (Ret.) and Dr. William A. LaPlante, with Robert Haddick



Lt. Gen. David A. Deptula USAF (Ret.) is dean of the Mitchell Institute for Aerospace Studies. **Dr. William A. LaPlante**, a former assistant secretary of the Air Force for acquisition, is senior vice president and general manager of the MITRE Corp.'s national security sector.

Robert Haddick is a visiting senior fellow at the Mitchell Institute. This article is adapted from the Mitchell research study, *Modernizing US Nuclear Command, Control, and Communications*.

Download it in its entirety at: www.mitchellaerospacepower.org.

For more than five decades, the forces of America's nuclear triad have prevented the use of nuclear weapons. Today, however, the average age of aircraft in the air leg is about 50 years, the Minuteman III intercontinental ballistic missile is also approaching 50, and the Navy's *Ohio*-class ballistic missile submarines are approaching 40 years in service. Urgency is building among policymakers and in Congress to modernize these systems and sustain the nuclear triad. At the same time, Russia and China are actively fielding new nuclear-capable systems—including new land-based strategic missiles, ballistic missile submarines, sea-based strategic missiles, and improved air-launched nuclear weapons, along with tactical nuclear weapons.

While modernizing the triad's weapon systems is now planned and under debate, a critical underpinning system that enables their success tends to get less attention: the nuclear command, control, and

Photo: Mass. Comm. Spc. Julie Matyasick/USN



Photo: TSgt. Fernando Sema

SrA. Scott Fowler (r) and SrA. Paul Gallegos (l) move the re-entry system of an LGM-30 Minuteman III missile onto a guidance set. The missiles are almost 50 years old.

communications enterprise (known as “NC3” in Pentagon parlance). This system allows the no-fail control of nuclear weapon systems in peacetime and, if necessary, in combat. The NC3 enterprise combines all the activities, processes, and procedures performed by military commanders and support personnel that ensure that decisions on the employment of nuclear weapons can be made under the direst of circumstances.

The highly classified nature of these activities means that little has been written about what, exactly, the NC3 architecture is, or what it does. The Mitchell Institute’s latest study, *Modernizing US Nuclear Command, Control, and Communications*, explains this system in an unclassified manner in order to convey the criticality of modernizing it. Only with a modern NC3 system can the US retain a resilient and robust command and control architecture that will guarantee the fundamental effectiveness of the nuclear triad and nuclear deterrence. In this regard, NC3 represents the critical “fifth pillar” of the United States’ nuclear modernization program, which also includes the triad’s three main weapon systems (land-based intercontinental ballistic missiles, submarine-launched ballistic missiles, and strategic bombers) and the nuclear warhead stockpile.

RECAPPING THE WHOLE NUCLEAR ENTERPRISE

Although NC3 is the least-expensive of these five elements of the nuclear modernization program, in many ways, it is the most critical. The Department of Defense is now moving out on a long overdue effort to recapitalize and modernize all three weapon systems of the nuclear triad today. Development and acquisition of a new intercontinental ballistic missile (the Air Force’s Ground-Based Strategic Deterrent, or GBSB, which will replace the Minuteman III), a new fleet ballistic missile submarine (the Navy’s *Columbia*-class nuclear submarine, which will

replace the *Ohio*-class), a new stealthy long-range bomber (the Air Force’s B-21 Raider, which will eventually replace the B-2 fleet in full), a new nuclear-armed cruise missile (the Long-Range Standoff weapon, or LRSO, will replace the AGM-86B Air Launched Cruise Missile), and the refurbishment of the nuclear warheads for these systems have understandably received great attention from Congress and policymakers. But these new weapons and platforms, as modern as they will be, cannot provide convincing deterrence unless the US also possesses an effective and robust NC3 enterprise that ties them all together. The existence of such a system is critical to convince potential adversaries that any attempted nuclear aggression will fail and be answered by a devastating response.

An effective NC3 enterprise performs five key functions:

- Provides current information on the status and readiness of all nuclear forces
- Allows prompt decision-making during a crisis and provides the basis for adjusting war plans as a crisis evolves
- Collects information from sensors, warning systems, and intelligence sources to provide comprehensive situational awareness to policymakers and commanders
- Provides the President and his subordinates with the ability to organize real-time conferences from disparate locations in the midst of a crisis
- Provides for the positive authorized control of nuclear weapons in peacetime and, if necessary, the employment of those arms in war

A modern NC3 system includes terrestrial, airborne, and space-based sensors that monitor the globe for threats; a communications architecture that reliably transmits (under any conditions) relevant and accurate data to decision makers; command and control support systems that provide decision makers with reliable analyses of threats and response options; and robust connectivity to ensure



Photo: SrA. Breanna Carter

Inside a launch control center in the 90th Missile Wing complex, 2nd Lt. Teah Heidern participates in a simulated Minuteman test. The site communication gear dates from the 1980s.

that weapon systems and operators are always connected to authorized decision makers, all the way up to the President. This NC3 system must always reliably transmit the President's orders through the chain of command to nuclear forces, such that those orders are always executed without fail. Yet, at the same time, the NC3 system must also ensure that nuclear weapons are never employed without proper authorization.

MODERN THREATS TO NC3

The currently operational NC3 system was first designed decades ago, in response to the threat posed by the Soviet Union's bombers, at first, and later its land- and submarine-based ballistic missiles. The US NC3 architecture received its last major upgrade in the 1980s in the waning years of the Cold War when the Soviet ballistic missile threat was reaching peak intensity.

Since then, however, the character and dispersion of nuclear threats to the US have only grown more complex. Advances in military technology, and the will of potential adversaries to employ it, have created threats to the NC3 system that were not present during the Cold War. Today's adversaries have the ability to attack early warning and communications satellites connected to the NC3 system, launch offensive cyber attacks on NC3 architecture, and employ potential nuclear weapons effects on modern NC3 support systems.

Perhaps the most pronounced difference is the increasing vulnerability of US space assets to attack or disruption. During the Cold War, both the US and the Soviet Union tacitly recognized that designating geosynchronous orbit as off-limits to attack would enhance mutual deterrence. That understanding has now largely disappeared. The number of state and non-state actors capable of space access and operations continues to grow, and the number of orbital objects expands every year. China and Russia have both declared they are pursuing counterspace weapons to threaten assets in geosynchronous orbit, with the Chinese carrying out widely publicized tests of anti-satellite weapons in 2007, 2013, and 2014. These capabilities place major space-based components of the US

NC3 architecture at risk, including the Space-Based Infrared System (SBIRS), which monitors satellites, and NC3-related communications satellites like the Advanced Extremely High Frequency (AEHF), a secure communications constellation.

Another profound factor to consider is how cyber security must be taken into account with any NC3 modernization effort. Much of the current NC3 system predates the internet era, when internet-protocol (IP) packet transmission became the dominant method of data communication.

But today's new equipment is built on IP-based subsystems, and as those systems are acquired and attached to command and control networks, the NC3 system must adapt to accommodate and support those characteristics without jeopardizing security. This introduces cyber risks to a system that was built before the modern cyber era. Other elements of NC3 infrastructure may also rely on support services, such as electrical power, water, fuel, and human support, any of which an adversary might attempt to disrupt through cyber attacks in order to affect NC3 performance.

Modern nuclear exchanges could also be different than the scenarios forecasted during the Cold War. American NC3 was initially designed to function through all phases of a nuclear attack and was upgraded in the 1980s to sustain operations through a prolonged nuclear war lasting as long as several months. But current threats are more complex. For example, Russia conducts training exercises displaying the limited use of theater nuclear weapons as a means of achieving decisive leverage during potential regional crises. Russian doctrine presumes that opponents will capitulate after a limited theater nuclear attack. The current NC3 systems of both the US and its allies protected by extended deterrence may come under stress from such limited theater employment of nuclear weapons, whether by Russia or another nuclear-capable adversary. In these scenarios, nuclear effects could potentially impair the theater elements of NC3 systems, inhibiting early warning, sensors, multinational leadership conferencing, and prospective orders to theater-based forces.

Finally, the legacy NC3 system is aging. It has not received a comprehensive upgrade since the 1980s and many of its components can be described as "vintage." It is difficult to maintain today and soon must be reliably connected to the new generation of nuclear weapon platforms described above when they enter service in the coming decade. Ensuring reliable communications between these new platforms and a half-century-old NC3 system will likely entail dangerous risks.

AN ENTERPRISE APPROACH

In July 2018, in recognition of NC3's importance, the Secretary of Defense and Chairman of the Joint Chiefs of Staff designated the commander of US Strategic Command (STRATCOM) as the "NC3 enterprise lead." The STRATCOM commander now has responsibility for the system's operations, modernization, design requirements, engineering, and integration—a change DOD leadership made to consolidate the committee-like management structure that had previously governed NC3 matters. With the new designation, the Department of Defense now has a single four-star general and combatant commander in charge of efforts to modernize the NC3 enterprise.

The 2018 Nuclear Posture Review (NPR) has already indicated some areas of focus that NC3 modernization should address. These include:

The USS *Pennsylvania*, an Ohio-class nuclear submarine, moves through the Hood Canal in Washington state following a strategic-deterrent patrol.



Photo: PO1 Amanda Gray/USN

- Strengthening protection against space-based threats by increasing the agility and resilience of NC3-related space assets

- Improving protection against cyber threats

- Enhancing integrated tactical warning and attack assessment capabilities by upgrading the SBIRS constellation, ground-based missile warning radars, and nuclear detonation sensors, and also improving the integration of data from these systems

- Improving command posts and communications links by upgrading mobile command posts—such as the Air Force’s E-4B National Airborne Operations Center and the Navy’s E-6B Mercury—ground-based command hubs and data links, and transmitters and terminals across the NC3 enterprise

- Advancing decision support technology, such as data-analysis tools and information displays, to assist presidential decision-making

- Integrating planning and operations at the regional command level to allow commanders to better coordinate prospective nuclear and non-nuclear military operations, thus enhancing overall deterrence

- Reforming governance of the overall NC3 enterprise

These are all important focus areas, and DOD has already moved out on some of these initiatives (consolidating NC3 management under the STRATCOM commander being the highest-profile move thus far). But modernization must also take care to address the threat posed by counterspace weapons: Any next-generation NC3 system will have to mitigate threats to space-based NC3 assets with countermeasures, rapid replacement, or both.

Several lines of effort should be pursued to address these threats, including advancing diplomatic dialogue with China, Russia, and others to establish norms of behavior and to reiterate the US view that it reserves the right to retaliate with nuclear weapons if an adversary were to launch a significant attack on NC3 or warning and attack assessment capabilities. Other avenues to address counterspace threats include increasing the dispersion of space assets, utilizing commercial and multinational space platforms to add redundancy and increase the targeting problem for potential adversaries, and building the capability to rapidly replace NC3 space assets by expanding inventories of replacement satellites and having launchers capable

of placing them quickly into orbit. Finally, DOD needs to formulate operational concepts that attack adversary counterspace assets, such as launch facilities, space command and control nodes, ground-based weapon facilities, and other infrastructure.

Finally, the US must be vigilant about cyber threats to NC3. All new weapon systems associated with the nuclear triad, from the B-21 to the *Columbia*-class submarine and the LRSO cruise missile, will be designed to modern technology standards. The President and senior leaders will have to use the NC3 system to communicate and maintain command and control of both conventional and non-nuclear crises, requiring the NC3 system to interface outside its once closed, segregated operational environment. This will assuredly raise new cyber vulnerabilities.

Designers of the future system must adopt the most advanced cyber defense best practices, many of which are not yet widely used across the US military. This will require STRATCOM to collaborate with commercial entities and federally funded research and development centers, which have superior expertise in cyber resilience.

Modernization of NC3 will be an open-ended process that will likely intensify over the coming decade. STRATCOM and DOD planners will have to refine a modernized NC3 system design that responds to the future threat environment, secures the cooperation of stakeholders across the US government, incorporates best practices, and obtains institutional and funding support from Congress.

PRESERVING NUCLEAR DETERRENCE

The 2018 NPR discusses the aging legacy NC3 system, the challenges posed by the emerging threat environment, and the need for modernization. The current STRATCOM commander, Air Force Gen. John E. Hyten, has termed the NC3 system his greatest concern and highest priority, and the US Air Force, which is responsible for about 75 percent of the NC3 architecture, is now moving out on a modernization effort.

The commander of STRATCOM now has the mission and necessary authorities to organize, plan, and lead a holistic modernization effort of NC3. When successful, this program will result in a future architecture that will guarantee connectivity between the president and US nuclear forces in even the most challenging scenario. ❏

Bring 'Em Back Alive

Combat search and rescue's golden era was Vietnam.
The world changed after that.



A downed USAF F-105 pilot awaits rescue in tall elephant grass in Southeast Asia in this 1972 Vietnam War photo.

By John T. Correll

The world's first combat rescue by a helicopter took place in northern Burma in April 1944. A light L-1 liaison airplane, flown by an American pilot with three wounded British soldiers aboard, had crashed behind enemy lines. There was a clearing in the jungle, but it was too small for conventional aircraft to land.

Fortunately, a YR-4 helicopter—one of only 30 then owned by the entire US Army Air Forces—was available. Lt. Carter Harman set it down in the clearing and took the survivors to an improvised landing strip on a sandbar in a river nearby, where other liaison aircraft picked them up.

It was a preview of the future of combat search and rescue, particularly of operations in the Viet-

“In World War II, an aircrew member downed behind enemy lines was virtually certain of capture or death.”

—Historian Earl Tilford Jr.

nam War 20 years later, when Air Force rescue crews saved almost 4,000 airmen, soldiers, and sailors from captivity or worse.

Prior to World War II, there had been no requirement for large-scale aircrew rescue. “In World War II, an aircrew member downed behind enemy lines was virtually certain of capture or death,” said historian Earl H. Tilford Jr.

Much of the flying was over water, and rescue capability was organized primarily for recovery at sea. The mainstay of the program was the high-wing PBY Catalina flying boat. Airmen were also picked up by ships and used plywood boats dropped to them by B-17 bombers. By March 1945, 1,972 American fliers had been saved in the North Sea, the English Channel, and adjacent waters.

The R-4, forerunner of the YR-4 flown by Harman

in Burma, was the first production helicopter, a new kind of flying machine developed by Igor Sikorsky. The first models for service with the AAF were delivered in December 1942. They showed enough promise that the Army ordered more of them, but they were not used extensively in World War II.

Postwar, the search and rescue mission and helicopters were assigned to Air Rescue Service, established under Air Transport Command in 1946 and moved to the Military Air Transport Service when it was created in 1948.

KOREA

All of the services had helicopters in the Korean War. The best known of them today is the Bell H-13, featured in the television series "M*A*S*H" transporting wounded soldiers from the battlefield to mobile Army surgical hospitals.

Elements of the USAF 3rd Air Rescue Squadron in Japan arrived in Korea with H-5 helicopters in July 1950. Older readers may recall the H-5 as the helicopter in which Mickey Rooney attempted to recover Navy pilot William Holden from a rice paddy in the movie "The Bridges at Toko-ri."

Rescuing downed airmen was the top priority for Air Force helicopter crews in Korea, but their H-5s and the follow-on Sikorsky H-19s performed seven times more medical evacuations than aircrew rescues. The H-19s began arriving in 1952 and eventually replaced the H-5s, which were phased out of the inventory in 1955.

Army helicopters did most of the battlefield medical evacuations, but Air Rescue Service handled about 30 percent of them. During the three-year run of the war, 1,690 Air Force crew members went down inside enemy territory. The Air Rescue Service saved 102 of them with helicopters, 66 with SA-16 amphibious aircraft, and two by small liaison planes. In addition, ARS extracted 84 airmen from other services and allied air forces from behind enemy lines.

The rescue force from Korea was not suited for the conflict that followed in the jungles of Southeast Asia. In any case, the Air Rescue Service lost most of its helicopters in the budget cutbacks of the 1950s. By the early 1960s, the Air Force rescue capability consisted mainly of the Kaman HH-43 Huskie, a utility helicopter used mainly for emergency fire suppression on the runway and bringing in airmen who bailed out in the vicinity of the base.

PEDRO AND THE PJS

The HH-43s deployed to bases in South Vietnam and Thailand in late 1964. For the next two years, they were the only Air Force rescue helicopters in Southeast Asia. The first combat rescue was March 2, 1965, when a forward-deployed HH-43 picked up an F-105 pilot shot down near the Demilitarized Zone on the first day of Rolling Thunder, the air war against North Vietnam.

The rescue variant of the Huskie, the HH-43F, was known as "Pedro" from its radio call sign. It was a small helicopter, just 47 feet from end to end, with no armor or weapons. Nevertheless, in the final accounting, Pedro was credited with more combat saves than any other helicopter in the Vietnam War.

Pedro was superseded by the larger and more capable HH-3s and HH-53s in the rescue role but remained in service in Southeast Asia until 1975, making the HH-43 not only the first search and rescue helicopter in the theater, but also the last.

The standard rescue device was the "jungle penetrator," lowered to the ground on a cable from the helicopter. It had spring-loaded arms to part the foliage and to provide a seat for the airman coming up or for the "PJ" pararescue jumper going down to get him.



Photo: USAF

An HH-43F "Pedro" crew hoists a downed airman to safety in Southeast Asia.

When configured for jungle rescue, Pedro carried two pilots, a crew chief, and a PJ, plus the penetrator, a litter, a stretcher, and medical kits. The terms PJ and "pararescue jumper" were said to be derived by working backward from letter codes on an aircrew flight log, with "P" for parachutist and "J" for diver.

The PJs were medical technicians as well as survival specialists. They descended into jungles and swamps to stabilize the injured and bring out the survivors, often under fire. All of them were volunteers.

Among the most famous was A1C William A. Pitsenbarger, a PJ on one of two HH-43Fs responding to a call for help by a US Army rifle company isolated and surrounded by a Viet Cong battalion in the dense jungle east of Saigon on April 11, 1966.

Pitsenbarger rode down on the forest penetrator to help the wounded, whose numbers were mounting. The two helicopters made five flights carrying out survivors before they were forced to retreat by intense fire from the VC. Rather than depart with them, Pitsenbarger chose to remain at the battle site, exposing himself to the enemy as he aided the injured and assisted in the defense. He was hit four times himself, the last round killing him. Pitsenbarger was awarded the Medal of Honor posthumously.

THE FIRST 45 MINUTES

Southeast Asia was a difficult operating environment, but on balance it was more of a problem for the enemy gunners than for the rescue helicopters. "Terrain became a useful ally rather than a troublesome hindrance to combat rescue units with the proper equipment," said historian Tilford.

The anti-aircraft guns "were limited by the same jungle that concealed them," Tilford said. The helicopters were often screened by mountain ridges, karst outcroppings, and trees. Airmen on the ground could hide in the jungle while waiting for rescue forces to arrive. In any case, it was risky business: During the Vietnam War, 71 Air Force combat



Photo: USAF

An HH-3 crewman fires a minigun during a rescue patrol over South Vietnam in 1972.

rescue crew members were killed in action, and 45 of their aircraft were lost.

The helicopters worked as part of a search-and-rescue task force, which included a control airplane and fighter escorts. The A-1 Skyraider, a single-engine, propeller-driven veteran of World War II, was a frequent companion. It had a long loiter time, helpful in locating survivors, and substantial armament to suppress enemy ground fire. The A-1H variant, which flew with the rescue missions, was known as “Sandy” from its call sign.

One helicopter in the task force, designated as the “low bird,” went in to make the recovery, while the “high bird” stood by to assist if needed or to extract the low bird crew if they were shot down themselves.

Up to the middle of 1967, when the helicopters finally gained air-refueling capability, range and time were significant concerns. “Rescue crews sought out clearings in the jungle to use as forward operating locations, where they could stockpile fuel and await calls for help many miles and minutes closer to a downed pilot,” said the official USAF history of the war.

In almost half of the rescue efforts that failed, the critical factor was arriving too late. The chance of success was excellent if the helicopter got there within 15 minutes of the airplane crashing or being shot down. After 45 minutes, the likelihood of rescue diminished sharply, although in some instances, airmen on the ground managed to hold out and evade capture for extended periods.

BIGGER AND BETTER HELICOPTERS

The HH-3E—most famous of the rescue helicopters and called the “Jolly Green Giant” because of its green and brown camouflage—reached Southeast Asia in November 1965. Flying from Udorn in Thailand or Da Nang in South Vietnam, it could reach any point in North Vietnam.

The HH-53C, dubbed the “Super Jolly Green Giant,” got there in 1967. From the middle of 1967 on, both the HH-3 and the HH-53 had aerial refueling capability, so their range was limited only by crew endurance. Unlike Pedro, they had

protective armor and they were also much faster. The HH-53 could reach speeds in excess of 190 knots in a dash.

The hefty HH-3 dwarfed the little Pedro, and the HH-53 was twice the size of the HH-3. The Super Jolly carried two PJs and up to 24 litter patients. However, the HH-53 was too large to maneuver in some valleys and other tight areas.

Pedro had gun mounts but seldom carried weapons. The Jolly Green had two 7.62 mm M-60 machine guns. The Super Jolly had three 7.62 mm gatling-type miniguns that could spit out up to 4,000 rounds per minute.

Despite the guns and armor plating, the big helicopters were still vulnerable at lower altitude. Even when traveling at top speed, the fastest of them, the HH-53, was within tracking range of various enemy guns for 30 seconds or longer. Small arms could do damage as well.

On Nov. 8, 1967, a North Vietnamese battalion ambushed a US-South Vietnamese patrol a few miles inside Laos and set up a “flak trap” for the rescue force that would be coming soon. Two helicopters—a South Vietnamese H-34 and a US Army UH-1B Huey—were shot down on arrival.

Two USAF HH-3E Jolly Green Giants came next. They retrieved several survivors but were advised to depart as the flak trap intensified. Capt. Gerald O. Young, flying the high bird, declined to go. Young’s PJ brought up two more wounded before the right engine of the helicopter exploded, hit by a rifle-launched grenade. The HH-3E flipped over on its back, burst into flames, and crashed.

Young, hanging upside down by his seat belt, managed to get out, although burns covered a fourth of his body. He used his hands to put out the fire in the clothing of an army sergeant who had been thrown clear. As the North Vietnamese closed in, Young led the enemy off into the jungle and away from the survivors. Despite drifting into shock from time to time, he eluded capture for 17 hours, and was found and rescued five miles from the crash site. A few more survivors were rescued in subsequent efforts. Young was awarded the Medal of Honor.

NUMBERS

In January 1966, Air Rescue Service was renamed Aerospace Rescue and Recovery Service under the new Military Airlift Command. The 3rd Aerospace Rescue and Recovery Group was set up at Tan Son Nhut Air Base in Saigon as the primary rescue agency for the theater.

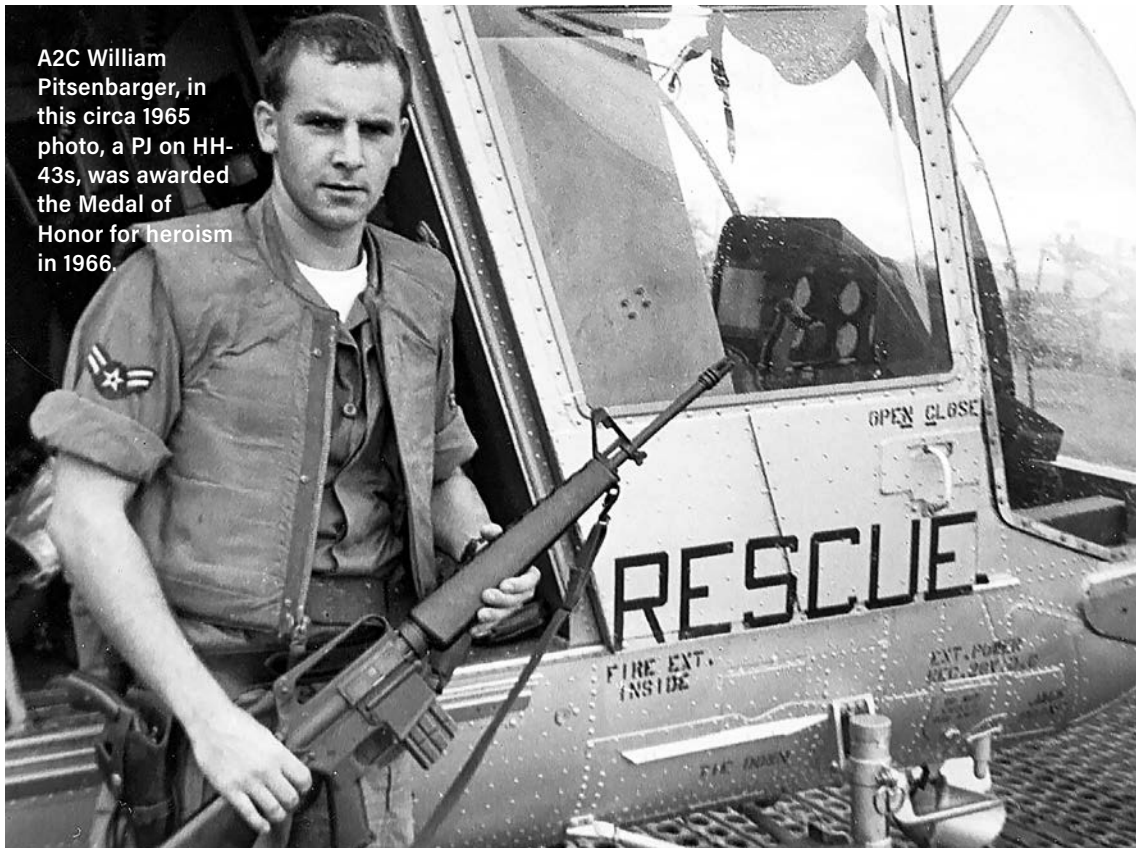
ARRS strength in Southeast Asia peaked in the summer of 1969 with 71 rescue aircraft operating in four squadrons in South Vietnam and Thailand.

Air Force rescue crews are credited with saving 3,883 lives in Southeast Asia between 1964 and 1963. Of these, 2,807 were US military: 1,201 Air Force, 926 Army, and 680 Navy. The others were allied military members and civilians.

Almost two-thirds of these rescues took place in South Vietnam. Seven percent were in North Vietnam, and the rest were in Laos and Cambodia. They were divided about equally between aircrew and non-aircrew rescues. In the 3rd ARR Group’s tally of 2,039 combat saves between 1966 and 1970, the HH-43 Pedro accounted for 43 percent, followed by the HH-3 Jolly Green with 37 percent.

The Navy made some 225 rescues of aircrew members during the war, most of them airmen downed in the Tonkin Gulf or a few miles inland.

During the Vietnam War, the Aerospace Rescue and Recovery Service “became the greatest combat aircrew recovery force in the history of aerial warfare,” said Tilford. However,



A2C William Pitsenbarger, in this circa 1965 photo, a PJ on HH-43s, was awarded the Medal of Honor for heroism in 1966.



Capt. Gerald Young, Medal of Honor recipient, flew the HH-3E.

Photos: USAF

the operations had been against lightly armed forces in an area with geographic features favorable to search and recovery. It was questionable whether similar success could be expected “in the highly defended, relatively open areas of Europe” or “the flat sands of the Middle East.”

CHANGING FOCUS

When the Vietnam War ended, so did nearly all of the demand for combat search and rescue. The mission declined in importance and as a funding priority.

The effort with the highest visibility over the next decade was the “Desert One” fiasco, the aborted attempt in April 1980 to rescue American hostages in Iran. It was conducted with Navy RH-53D Sea Stallion helicopters flown by Marine Corps aircrews. It was a special operations venture, rather than search and rescue, and no ARRS units took part.

Later that year, the best of the ARRS helicopters, the HH-53 Super Jollies, were transferred to the 1st Special Operations Wing of Tactical Air Command. By the time the Gulf War began in 1991, considerable separation had developed between combat search and rescue and special operations.

“On the eve of Desert Storm, Air Force CSAR capability had been dramatically reduced from its peak during the war in Southeast Asia,” said historian Darrel D. Whitcomb. “Its primary recovery helicopters, the HH-53s, had been transferred to special operations. The remaining HH-3s were marginally combat-capable or survivable in a high-threat area. New HH-60s were only beginning to arrive.”

Search and rescue in the Gulf War was controlled by the joint special operations component, which was headed by an Army colonel. Some Air Force officers were dissatisfied with the level of effort. Only seven search and rescue missions were launched. Of the 64 airmen shot down, three were rescued and 19 became prisoners of war. As Whitcomb points out, most of the aircraft that were lost went down in high-threat

areas under enemy control. In many instances, an attempt at rescue was not feasible.

The combat search and rescue mission was reassigned to Air Combat Command in 1993, then to Air Force Special Operations Command in 2003, and back to ACC in 2006. Currently, ACC, the Guard and Reserve, and overseas commands all fly the medium-lift HH-60G Pave Hawk, which has replaced the HH-3E Jolly Green in the rescue role.

The last of the MH-53 Pave Low helicopters—the Super Jolly variant for special operations—was retired in 2008. AFSOC now uses the CV-22B Osprey tilt-rotor aircraft for inserting and recovering special operations personnel.

THE NEXT GENERATION

Today, the Pave Hawk fleet is 30 years old and in dire need of replacement. The helicopters have been used hard and are challenging to maintain.

The Air Force planned in the early 2000s to acquire the CSAR-X, a larger and more capable helicopter that would have carried three PJs and four litter patients, compared to two PJs and two litters on Pave Hawk. In 2009, though, Secretary of Defense Robert M. Gates canceled CSAR-X, calling it “yet another single-service solution with a single-purpose aircraft.”

In 2014, Sikorsky won a contract for the HH-60W, based on the Black Hawk design and to be called Pave Hawk II. The Air Force settled for “narrowed requirements” compared with CSAR-X, but the new combat rescue helicopter will still have increased range and more cabin space than the HH-60G, as well as improved technology. The program is going well, and Sikorsky has advanced the date for projected first deliveries to March 2020. ✪

John T. Correll was editor-in-chief of Air Force Magazine for 18 years and is a frequent contributor. His most recent article, “Peacekeeper by Fits and Starts,” appeared in the March issue.

By Rachel Cox

Maj. Gilberto S. Perez

Home State: Florida

Chapter: Hurlburt Chapter (Fla.)

Joined AFA: 2013

AFA Offices: Steele Chapter EXCOM; AFA National Membership Committee; Hurlburt Chapter EXCOM; Aerospace Education Council

AFA Award: AFA Leadership Recognition Award (AFA Virginia)

Military Service: 11 years, Active Duty

Occupation: Commander, 505th Communications Squadron, Hurlburt Field, Fla.

Education: B.S., Management, United States Air Force Academy; M.B.A., Management, University of Tampa; M.S., Military Operational Art and Science, Air Command and Staff College



Maj. Gilberto Perez

What do you enjoy most about your AFA membership?

Joining AFA takes you beyond the Profession of Arms into an Air Force family, where airmen across the Total Force and generational lines come together for a common purpose—to educate, advocate, and support one another. The relationships developed through the years are what I truly cherish the most out of my membership.

What is your favorite AFA program, event, or project?

This is a difficult question. My AFA Top 3 would be the Wounded Airman Program, youth aerospace/STEM education programs (CyberPatriot and StellarXplorers), and professional development events (Air Warfare Symposium

and Air, Space & Cyber Conference). These activities take care of airmen and prepare leaders in the defense of our nation.

How did you first hear of AFA?

Lt. Gen. Michael Basla, previous Air Force chief information dominance and chief information officer, visited my local base. His official military biography was disseminated prior to his arrival, and I noticed he was a lifetime member of the Air Force Association. This was my first exposure to AFA, which led to further research about what AFA was all about.

What prompted you to join?

I was captivated by AFA's proud heritage of supporting the Air Force, from playing an integral role in standing-up an independent Air Force in 1947, founding the Community College of the Air Force, sponsoring the Outstanding Airmen of the Year, and creating the Air Force Memorial, to name a few. AFA truly stands behind us its mantra of being "The Force Behind the Force," in both words and actions.

How has AFA helped you?

AFA provided me an opportunity to learn more about the "Air Force family business" and grow professionally. This has allowed me to be a better leader for my airmen and organizations I am a part of because of the greater understanding of Air Force history, issues, and current events. More importantly, the relationships garnered throughout the years have helped shape my perspective and given me strength on and off-duty.

How do we build awareness about AFA?

Awareness starts locally from the field, where relations are fostered and AFA support is tailored to the needs of the community. Social media is a great conduit to share information, but placing an emphasis on personal interactions enables people to share an experience and see AFA benefits firsthand.

SMSgt. Sonora L. Vasquez

Home State: California

Chapter: Alamo Chapter (Texas)

Joined AFA: 2016

AFA Offices: Treasurer, Alamo Chapter; National Membership Committee

Military Service: 1999-present, Active Duty

Occupation: Superintendent, Transitions Division, Air Force Personnel Center, JBSA-Randolph, Texas

Education: M.S., Human Resources, Brandman University



SMSgt. Sonora Vasquez (right) with her husband Ruben Gonzalez.

What do you enjoy most about your AFA membership?

I enjoy the networking and professional development opportunities.

What is your favorite AFA program, event, or project?

My favorite event is the annual "Combat Breakfast" sponsored by the Alamo Chapter. It is one of a series of events hosted by the San Antonio Chamber of Commerce to honor the men and women in America's military.

How has AFA helped you?

AFA has strengthened my awareness of national policy, and provided me with a perspective and understanding of how the Air Force functions within a democratic republic.

How do we build awareness about AFA?

I would recommend connecting with current members and providing up-to-date information on upcoming events, national initiatives, etc.; continuing to utilize social media platforms, including LinkedIn, Facebook, and Twitter; creating engaging, short content that quickly captures the brand and the viewers' attention; encouraging chapters to sponsor local events; and seeking avenues to appeal to Generations X-Z (i.e., show "Generation Me" why it's important to join).

How did you first hear about AFA?

Through a mentor, after I requested a recommendation of a professional organization.

Why did you join AFA?

I received a free membership through the "Every Airman a Member" program several years ago. Not having an active chapter near my assigned location during that period deterred me from renewing my membership. In August 2016, I arrived at my new duty location at JBSA-Randolph, Texas, and several organizations interested me. I had been associated with several in the past and elected to commit myself to the first organization that responded to my inquiry. Debbie Landry, Alamo Chapter president, contacted me within hours of my query, and I have been an active member since.

TSgt. Christopher J. Pineda

Home State: California

Chapter: John C. Stennis Chapter (Miss.)

Joined AFA: 2017

AFA Office: Chapter Secretary

Occupation: Executive Assistant to 81st Training Wing Command Chief, Keesler AFB, Miss.; Primary AFS: Computer Systems Programmer

Education: A.A.S., Computer Science Technology, Community College of the Air Force; B.S., Management Studies, University of Maryland (In progress)

How did you first hear about AFA?

Through a Google search of Air Force professional organizations at or near my base.

Why did you join AFA?

I joined AFA because when I entered the Air Force, I became an "Airman for Life." That's why it's my responsibility to aid AFA in its mission of advocating for our dominant Air Force. My support helps AFA educate the public about all the good the Air Force provides 24/7/365.

What do you enjoy most about your AFA membership?

I enjoy reading *Air Force Magazine* because it exposes me to what is going on outside of my small corner of the Air Force.

What is your favorite AFA program, event, or project?

I admire AFA's Wounded Airman Program. Taking care of our wounded airmen and their families is a noble cause.

How has AFA helped you?

Being involved in my local AFA chapter has introduced me to airmen across the base and rank structure. Their unique per-



TSgt. Christopher Pineda (right) with his Command Chief, CMSgt. David Pizzuto, reviewing his calendar for the week.

spectives and experiences have helped me to grow as a person, thereby making me a better airman.

How do we build awareness about AFA?

Double and triple down on social media engagement. Everyone's attention is increasingly focused on their personal digital devices, and I don't see that changing. These devices are simply too valuable because of their ability to make our lives easier. If that's where the eyes are, that's where AFA needs a strong presence.

Paul M. Hendricks III

Home State: California

Chapter: Seidel Chapter (Texas)

Joined AFA: 1975

AFA Awards: AFA Medal of Merit; Exceptional Service Award

Military Service: 1970-1990, Active Duty

Occupation: Retired Program Manager

Education: B.S., Engineering, San Diego State College; M.S., Systems Engineering, Air Force Institute of Technology



Paul Hendricks III

How did you first hear of AFA?

I learned about AFA through presentations made by AFA members, which provided a description of the association and the benefits available to AFA members.

What prompted you to join?

I have a strong desire to support the Air Force through coordinated

efforts. I have also found it very rewarding to work and associate with members who possess similar objectives.

What do you enjoy most about your AFA membership?

I appreciate the comprehensive information that is provided in *Air Force Magazine*. The magazine provides a good summary of worldwide Air Force activities. This information has become very insightful for a military retiree.

How has AFA helped you?

AFA has provided a continuous awareness of worldwide Air Force activities and events. Additionally, the ability to advocate for specific causes to assist our Active Duty and veterans is also significant and beneficial.

How do we build awareness about AFA?

Awareness starts while Air Force members are still on Active Duty. Existing AFA members should meet with Active Duty members and provide information on how AFA is supporting the Air Force, as well as the veteran community. Additionally, our community should have the ability to become aware of AFA as an element to strengthen overall support for military relations and examine the opportunities for industrial-base growth.

Jamie Navarro

Home State: Vermont

Chapter: Green Mountain Chapter (Vt.)

Joined AFA: 1988

AFA Offices: Vice President, CyberPatriot; Committee Member, Wounded Airman Program; Chapter Vice President, Community Partners

AFA Award: AFA Medal of Merit

Military Service: 7.5 years, Active Duty; 2.5 years, Air Force Reserve

Occupation: Chief Operating Officer, Invictus International Consulting

Education: B.A. Mathematics, Syracuse University; M.P.A. (Public Administration) with concentration in National Security, Troy University; Executive Leadership Certificate, Cornell University

How did you first hear of AFA?

I joined Air Force ROTC and the Arnold Air Society at Syracuse University in 1988. I became active in my local chapter when I received a letter from them after returning to the US after several years overseas.

What prompted you to join?

It was a lifelong commitment to be a part of supporting the Air Force.

What do you enjoy most about your AFA membership?

I appreciate the people AFA has connected me with, both in my local chapter and, now, across the US. At my first local chapter meeting, I ate lunch next to a former World War II pilot who had been shot down and had spent time as a German prisoner of war. I never get tired of hearing people's stories of how and why they joined the Air Force and their experiences.

What is your favorite AFA program, event, or project?

CyberPatriot—but I'm a little biased because I've been leading our chapter's involvement in that program for more than six years now.

How has AFA helped you?

It has helped me stay connected with the Air Force and locally connect with our Vermont Air National Guard and the great airmen that are a part of—or who have retired from—that organization.

How do we build awareness about AFA?

We make an impact through sponsoring and bringing great programs from our national level to our chapters, such as CyberPatriot and the Wounded Airman Program. Our chapters connect us to our local communities, each in unique ways based on where they are and who participates.

AFA began an Emerging Leaders Program in 2013 as an avenue to secure AFA's future. The purpose of the program is to identify, motivate, develop, and encourage emerging leaders to serve actively in AFA by providing hands-on experience and unique insights into how AFA operates and is governed. Emerging Leaders volunteer for a year. With guidance from a mentor, they participate on a national-level council, attend national leader orientations, and serve as National Convention delegates.



Jamie Navarro

Courtesy photo



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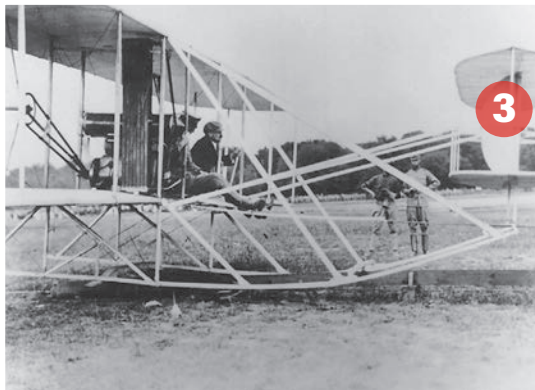


1

1/ Frank Lahm in WWI. 2/A C-130 at Mansfield Lahm Airport. 3/ Orville Wright and Lahm (left) seated in the Flyer before the July 27, 1909, flight.



2



3

Photos: San Diego Air & Space Museum; 1st Lt. Paul Sternett/ANG; USAF

LAHM Numero Uno

Ever since 1948, the Mansfield, Ohio, airport has hosted an Air National Guard base. The place is important but not flashy.

In that sense, Mansfield Lahm Airport resembles its namesake. Frank Lahm was a not-very-famous airman. The obscurity belies his record.

Lahm was America's very first military aviator, honored as such in 1962 by none other than Gen. Curtis E. LeMay, USAF Chief of Staff. And who taught Lahm to fly? The Wright Brothers.

Lahm was scholarly and something of a loner, which may explain why he has gone largely unheralded for decades.

Frank Purdy Lahm was born into a prominent Ohio family. An excellent student and fine athlete, Lahm entered West Point in 1897 and, in 1901, was commissioned a cavalry officer.

The cavalry was Lahm's nominal home for 19 years (he didn't formally join the Air Service until 1920), but he had the flying bug and spent years detailed to the Signal Corps for aviation work.

In France in 1906 to study European ballooning, he learned to fly himself and won a major balloon race. He met Orville and Wilbur Wright while convalescing from typhoid fever in Paris in 1907.

The Army in 1908 contracted to buy an airplane from the Wrights. Lahm was chosen for a nascent pilot corps. It was on Sept. 9, 1908, that Lahm boarded the Flyer and, with Orville piloting, flew above Fort Myer, Va., for 6 minutes, 24 seconds.

Thus did soft-spoken Lieutenant Lahm become the first on-duty US officer in history to go aloft in an aircraft.

The next summer, the Wrights brought a new Flyer to Fort Myer. On July 27, 1909, Lahm became the first officer

to make a flight in what became the Army's first airplane.

Later, the Wrights taught Lahm and Lt. Frederic Humphreys to fly. Both soloed on Oct. 26, 1909, at College Park, Md., making them America's first certified military pilots.

During World War I, Lahm organized the balloon service of the American Expeditionary Forces. He also organized and commanded the Air Service, Second American Army, a feat of organization.

After the war, Lahm's major contributions to aviation came principally in training and administration. He rose to become assistant chief of staff and helped develop new flying training centers.

In the period 1926-30, Lahm organized a new, centralized Air Corps Training Center in Texas. The dedication of the center at Randolph Field in June 1930 was a source of pride. He had the unofficial title of "Father of West Point of the Air."

Lahm's long military career ended in 1941. On Aug. 29, 1956, at 78, Lahm flew a T-33, completing his remarkable journey from wood and wire to jet power. He died in 1963.

In 1967, Mansfield Municipal Airport was renamed Mansfield Lahm Airport. The Ohio National Guard simultaneously dedicated the new Lahm Administration Building there. Today, Mansfield Lahm is home to the 179th Airlift Wing, a C-130 outfit.



FRANK PURDY LAHM

Born: Nov. 17, 1877, Mansfield, Ohio
Died: July 7, 1963, Sandusky, Ohio
College: US Military Academy, West Point, N.Y.
Occupation: US military officer
Service: US Army—Cavalry 1901-20 (many Signal Corps details); Air Service 1920-26; Air Corps 1926-41; Air Forces 1941.
Eras: Pioneer, World War I, Interwar
Years of Service: 1901-41
Combat Zones: Philippines 1901-03; Europe 1917-18
Final Grade: Brigadier General
Honors: Distinguished Service Medal; Legion of Merit; World War I Victory Medal; Legion of Honor (France); Military Order of Aviz (Portugal); inductee, National Aviation Hall of Fame; inductee, First Flight Society
Famous Friends: Orville Wright, Wilbur Wright, Alexander Graham Bell, Thomas Selfridge

MANSFIELD LAHM AIRPORT

State: Ohio
Nearest City: Mansfield
Area: 3.75 sq mi / 2,400 acres
Status: Open, operational
Opened as Mansfield Airport: 1925
Became ANG base: 1948
Renamed Mansfield Lahm Airport: 1967
Component: ANG/Air Mobility Command
Assigned tenant: 179th Airlift Wing
Former tenant: 164th TFG (and predecessors)
Owner: City of Mansfield, Ohio

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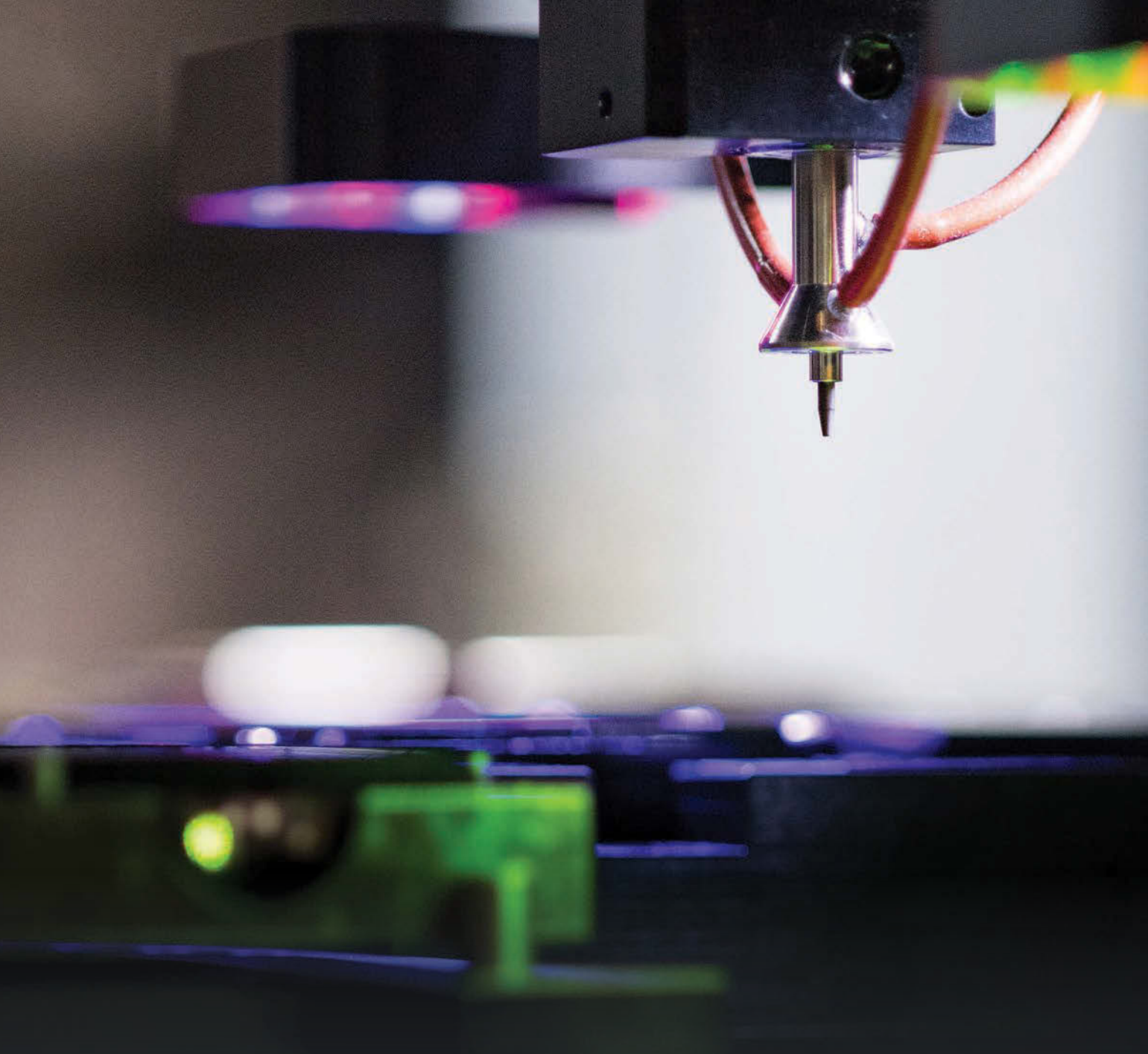
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