**How soon will the Fighter pilot go away?**

***"The Fighter Jet Era Has Passed, Elon Musk to the USAF: Autonomous drones are the future," Rachel S Cohen, Air Force Magazine, April, 2020 p 20-21***

In February 2020, at the AFA's annual Warfare Symposium, Elon Musk declared: "That the fighter jet era has passed."

What? No more fighter pilots in our Air Force? What's going to happen to our Air Force when we no longer have our combat flying heroes?

His statement was heard by our Air Force Chief of Staff, General David Goldfein, and caused a "rumble" among the audience dominated by Air Force officers and staff. *Automating the role of a human pilot is a threat to the traditional Air Force as we know it.*

Musk believes that drone technology has/will develop to the point, that unmanned jets armed with missiles will dominate future military air combat. Maybe not today, but in a few years, manned jet fighters will not be able to compete against the smaller, more maneuverable and much less costly manned jet fighters. Maneuverability can be more important factor than speed in close combat. (We learned this in Vietnam!)

**Costs will drive final decisions**

Just comparing cost, an F-16 costs around $35 million, the new F-35 costs around $100 million. These types of complicated systems cost billions to develop and also require a decade of more expensive R&D, during which many test pilots are lost. The design and construction of modern jet fighters also includes the very high cost of developing and testing the life support, ejection system, and other systems needed to support the human pilot. All these other human support systems also must be tested. In a modern jet fighter more than 50% of the space is needed for the pilot and his support systems.

The cost of an advanced combat drone is not clear at this time. But it is fair to assume that it will cost a lot less than our most modern fighter jets which includes a lot of systems and equipment to support the pilot. Depending on the amount of electronics needed, reconnaissance drones typically cost less than a million dollars.

Automating the role of a human pilot is a threat to the Air Force as we know it. In fact, once the number of Air Force pilots are drastically reduced, the entire culture of the Air Force will change dramatically. Maintenance personnel staffing will be drastically reduced. *Today, much of our maintenance staffing are needed to maintain the life support systems needed for pilots. Once the need for most pilots goes away, the maintenance effort and staffing will shrink.*

There also good reasons to presuppose that the crews needed to support our big jet tankers and jet transports will also eventually be dramatically reduced. Automating the advanced jet fighters like our F-22s and F-35s is much more complicated than maintaining the physically pilotless drones.

However, for the immediate future, the Air Force will still rely and depend on our well trained pilots. There will most likely be a lengthy transition phase where we will only partially automate our flying crews. Drones are already being used to reconnoiter and distract enemy radars.

But in the future world of drones, there will be new jobs for the specialists who will be needed to fly and maneuver our drones, often at great distances from their combat zones, and a good size technical staff to keep the drones maintained and flying. Drone operators controlling our fighters and bombers from long distances will be needed. There will be more technical skills required. These skillful technicians are already short staff. There is a lot of stress for drone operators who must review bomb damage videos and view the casualties caused by offensive drones.

Our electronic warfare staffs will need to be very competent to counter the drone capabilities of our opponents. The efficacy of our electronic combat capabilities will be crucial to our offensive effectiveness **and** our defensive effectiveness. Automatic systems will need more sophisticated electronic command and control, and our dominance in electronic warfare will be absolutely crucial for future air combat success. Every nation's offensive drones will be smaller, faster and maneuverable. Defense of advanced offensive drones will require more advance technology.

Today, the senior positions of the Air Force Command staff is comprised of Air Force pilots who may not be interested in automating our aircraft too quickly, but depending on the capabilities of our enemies, the increased pace of automating our air borne weapons could overcome their objections.

Elon Musk is right that pilots are going to be history, but may be not immediately. His forecast is not imminent, but the automation process is active and moving forward daily.

**B**oth China and Russia have been developing their own drone systems, for defensive and offensive weapons, and their capabilities are challenging us to be more innovative and effective. America has no choice but to invest and encourage our innovators to proceed and develop the most advanced drone technology. *The software development challenges may be more demanding than new hardware requirements*.

Ironically, the entrance of offensive drone technology helps us solve a current, major Air Force problem. We currently short about 2,100 pilots based on current staffing requirements. Drone technology will reduce our need to maintain an inventory of 21,000 pilots to meet near term manning requirements.

Financially, the cost of maintaining and training combat pilots, and everything needed to support these personnel goes away, as does the high cost to develop future manned jet fighters when drone development goes to the next stage. Great job opportunity for anyone capable of developing advanced drone technology, especially electronics.

**Sources:**

***"The Fighter Jet Era Has Passed, Elon Musk to the USAF: Autonomous drones are the future," Rachel S Cohen, Air Force Magazine, April, 2020 p 20-21***

[***https://www.nationaldefensemagazine.org/articles/2018/9/14/the-future--of-air-power***](https://www.nationaldefensemagazine.org/articles/2018/9/14/the-future--of-air-power)

**New Age of Autonomous Jet Fighters on Horizon**

**9/14/2018, By Stew Magnuson, *NATIONAL DEFENSE***

The scenario military thinkers propose would double the number of jet fighters in a typical battle formation from four to eight. But instead of the additional aircraft being identical to an F-35 joint strike fighter, or F-15E Strike Eagle, they are low-cost, unmanned jets.

One might carry extra air-to-air missiles. Another may only have a sensor suite to boost situational awareness for the pilots in the traditional aircraft.

Whatever their payload, the enemy has to contend with double the number of targets on their radars. They have multiple “dilemmas” in front of them, giving U.S. forces an asymmetric advantage.

Further, shooting down one of the U.S. aircraft or jamming its communications links would not completely degrade the battle formation.

**This scenario is part of a larger concept that has emerged from the Defense Advanced Research Projects Agency called “mosaic warfare.”** Like a real mosaic that creates a picture out of smaller pieces, battlefield commanders can take disaggregated capabilities, sometimes in the form of low-cost, expendable robotic systems, to make life complicated for opponents.

“What does a platform have to do? It has to sense. It needs to communicate. It needs to defend itself. It needs to do data processing,” Jim Galambos, a DARPA program manager in the strategic technology office, said in an agency podcast.

“What if we disaggregate? What if I took the sensing function and put it on an unmanned system so it can be farther away?” It could be higher in the air to obtain a better angle of the battle. Or there could be multiple sensing platforms and angles, he said.

“Adversaries are pouring lots of money to go after single platforms that are high value. … Do I go after one of the sensors? I might get one but not all. And by the way, the main aircraft or ship is still going,” Galambos said.

Like a mosaic, the whole idea is to bring many pieces together through automation and communications links. If a few pieces are lost, “you still get the picture,” he said.

Or the pieces can be rearranged to tell a different story. Commanders can re-compose them and execute a different mission. **Mosaic warfare is an attempt to bring together unmanned systems and manned systems**, he said. Such systems are linked today but aren’t truly working together as a team.

Making this concept a reality in air warfare will require autonomous jets, a technology that is feasible now, experts said.

Kratos Defense, for example, has invested its own research-and-development dollars to adapt its jet aerial target system for other applications, said Steve Fendley, the company’s senior vice president and president of its unmanned systems division. It then went around to various U.S. military labs such as DARPA, the Air Force Research Laboratory and Defense Innovation Unit-Experimental to make the case that its jet target system can fill the capability gaps that slower, lower altitude unmanned aerial vehicles can’t.

“Because these systems have the fighter jet-type performance capability, they are also very well suited toward the contested environment that is such a challenge today for the military — both from the manned side and the unmanned side,” he said in an interview.

The company is touting two aircraft for unmanned applications: the XQ-58A Valkyrie and the Unmanned Tactical Aerial Platform-22 (UTAP-22).

Skip Stolz, director of strategic development for the autonomy, control and estimation group at BAE Systems, said his company has the software backbone that would allow autonomous jets to fly today — whether they are adapted from old fighters, or something built from a clean-sheet design.

“We have gone beyond where this is a technology problem,” Stolz said.

Software products such as its Mission Effectiveness Augmentation System build on almost two decades of work, mostly on DARPA programs.

There are some missions that the software doesn’t perform yet such as close-air support and proximity to friendly troops. But “that will be coming,” he said.

The challenges to fielding robotic jets don’t revolve around technology, but rather pilot trust and a lack of tactics development, he said.

**“One of the main reasons we are talking about unmanned-manned teams is to take advantage of the strengths of the manned aircraft and to take advantage of the strengths of the unmanned aircraft,” he said.**

Humans are very good at critical thinking and intuitive decision-making. Machines can’t hope to match a human doing that, or at least they won’t for a long time, Stolz said.

Machines are good at processing large amounts of data rapidly to help the pilot in the manned aircraft come to correct decisions without him or her being inundated with information, he added.

**Retired Air Force Gen. Hawk Carlisle, former commander of Air Combat Command, and now president and CEO of the National Defense Industrial Association, predicted that there would** **be some kind of autonomous wingmen for jet fighters early in the next decade.**

“Clearly that’s where we are headed. We have to be. We have to get more with less and one way to do that is to offload the stuff that can be offloaded to a machine,” he said.

He envisions a scenario in the not too distant future when an F-15E Strike Eagle deploys with four drones: one doing reconnaissance, one doing electronic warfare, one with munitions, and another a decoy.

If the enemy aims a radar at the decoy, it can autonomously maneuver in such a way that it causes confusion. If the EW drone senses a radar it can start jamming procedures. The recon drone gives the pilot better situational awareness as to what’s happening. The backseat pilot in the F-15E can monitor the drones.

“The idea is to give the adversary things he can’t handle,” Carlisle said. If you don’t know who is a shooter and who is a sensor, or if he can’t tell the difference between an automated penetrating [drone] and a B-21 bomber, then you’re giving him more problems.”

Meanwhile, lone F-22 and F-35 pilots can keep tabs of the drones themselves because fifth-generation aircraft are now automatically doing the basic flying and sensing tasks. In the older aircraft Carlisle flew earlier in his career, these tasks were “all done in your noggin.”

The fifth-gen jets manage all that “so you can raise the pilot to a higher level of achievement doing more and better things,” he said.

The other advantage is for contested environments, which the military has said repeatedly will define the battle zones of the future.

Opponents are going to try to jam communications, Carlisle said. They will not only go after aircraft, but space and cyber systems. Disaggregation creates resilience.

“What we have to do is be resilient and healing so we can continue the fight in a graceful degradation or a resilient mode,” he said.

Fendley said Kratos’ unmanned jets are ideal for contested environments because of their speed. Low-altitude unmanned systems are difficult to protect in a contested environment. The UTAP-22 flies at Mach 0.91 and the Valkyrie at Mach 0.72.

“The ability to apply these to the current mission sets that aren’t being satisfied from an unmanned perspective goes way up,” he said.

The Mitchell Institute for Aerospace Studies recently released a policy paper titled, “Manned-Unmanned Aircraft Teaming: Taking Combat Airpower to the Next Level.” The study encouraged the Air Force to pursue a partnering concept where a manned F-35 could potentially team up with F-16s converted to autonomous jets for a variety of missions. That could speed up decision-making, bring down costs and fill capability gaps until new purpose-built jets come online, it said.

“Thanks to advancements in autonomy, processing power and information exchange capabilities, the Air Force will soon be able to fly traditionally manned combat aircraft in partnership with unmanned aircraft,” the report said. “Approaching this opportunity in a graduated fashion with limited risk allows the operational community to explore new concepts of operation and tactics in an evolutionary fashion.”

Fendley said the Kratos aircraft could also fit the bill. Their roots as targeting aircraft meant they were built to be inexpensive and expendable.

The jet engine is the most costly single item. Meanwhile, the aircraft do not have to be certified for manned flight, which also drives down costs, he said.

“We started from a production capability and a design capability based on aerial target systems that — by requirement — must be very inexpensive,” he said. “That same design philosophy is being applied to our tactical systems.

“We’re developing airplanes that have fighter-like performance capabilities. They’re unmanned and incredibly inexpensive to acquire and operate and maintain,” he added.

Stolz advocated starting out with older model jets such as F-16s. To build pilot trust and develop the tactics needed to advance manned-unmanned teaming will require lots of flight hours and repetition, he said. A “safety pilot” could at first be in the unmanned aircraft’s cockpit to help build trust.

The software can then be inserted in a clean-sheet design aircraft and the pilots would immediately accept it, he said.

Carlisle didn’t think the trust issue was a major factor. “I don’t think there is a cultural reticence. People say, ‘Pilots don’t like [remotely piloted aircraft].’ That’s garbage. It’s just not true. These are great platforms doing great things that assist the fight.”

Stolz pointed out another advantage of the autonomous jets: it takes years to train human pilots to be expert flyers. “Once we have that software right, once we have those tactics developed, I don’t have to train my airplanes anymore. My unmanned airplanes are instantly at the same level of expertise.”

Air Force Research Laboratory Commander Maj. Gen. William Cooley, speaking at a Mitchell Institute event, said his organization is developing a common architecture and framework for autonomous jets so it can employ more advanced software and hardware systems rapidly. “Having that common architecture that allows us to integrate different capabilities is essential,” he said.

Developing prototypes and having the contracting authorities to conduct experiments will also be critical, he noted. “I think we’re poised to be able to do that, but we’ve got to start making it happen.”

While the idea of using previously retired combat aircraft to perform an unmanned “loyal wingman” mission certainly has merit, the service might also eventually consider a dedicated, low-cost platform, Cooley said.

AFRL will conduct some experiments with Kratos’ XQ-58A this fall, he added.

“The basic idea is can we make a capable, combat-type aircraft ... by using modern manufacturing techniques and drive the cost as low as possible,” he added.

— Additional reporting by Vivienne Machi