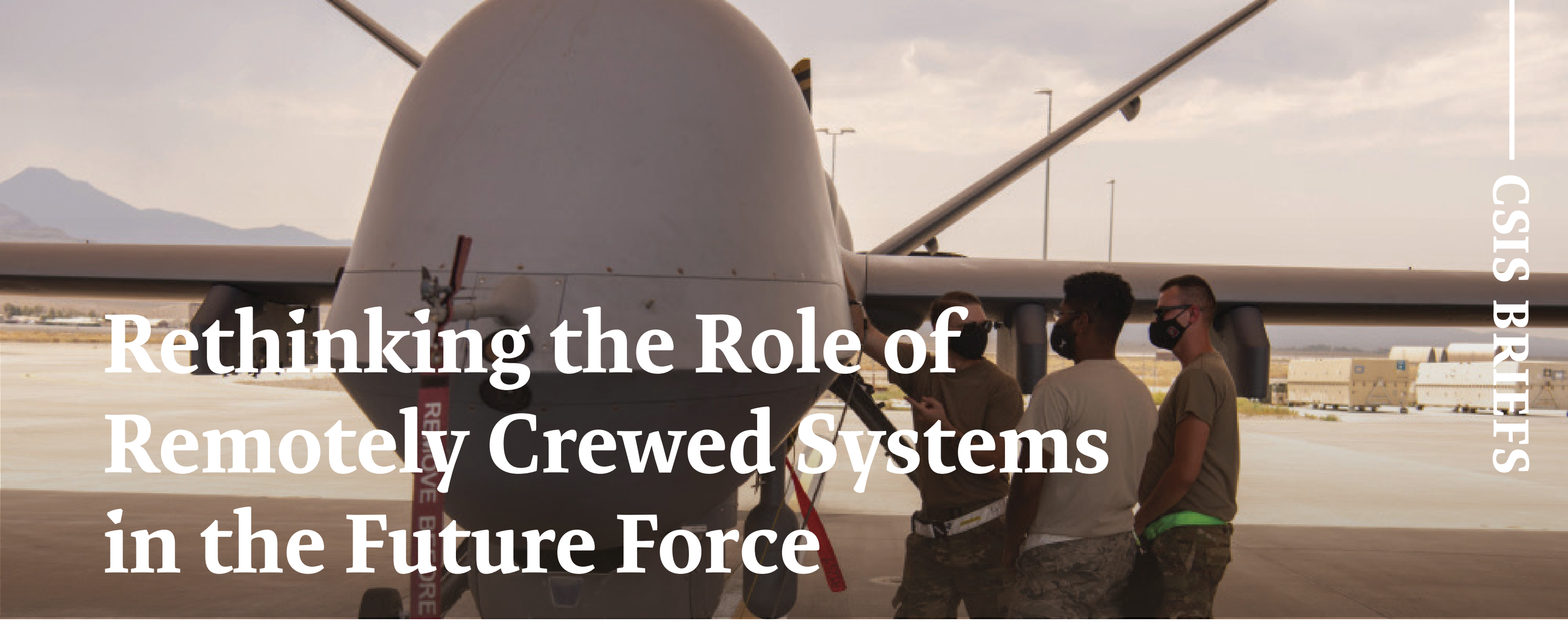

CSIS BRIEFS

Rethinking the Role of Remotely Crewed Systems in the Future Force

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THE ISSUE

- **One of the promises of remotely crewed systems is that they could be a force multiplier for the military,** either allowing it to increase force structure without a proportionate increase in personnel or to reduce personnel without cutting overall force structure.
- **As remotely piloted aircraft (RPAs) have been adopted into the military in large numbers** for airborne intelligence, surveillance, and reconnaissance (AISR), they have demonstrated much higher utilization rates and lower personnel and operating costs on a per-aircraft and a per-flying-hour basis than crewed AISR aircraft.
- **However, high demand from the combatant commands has prevented overall reductions** in personnel and operating costs or the substitution of RPAs for crewed AISR aircraft.
- **For remotely crewed systems to become an affordable and scalable alternative to crewed systems across all domains,** the U.S. military will need to rethink how units are staffed, organized, and trained to better leverage automation and develop new concepts for in-garrison operations.

INTRODUCTION

In the wake of the cuts driven by the Budget Control Act of 2011 (BCA), many senior military and political leaders lamented the effects these cuts were having on the U.S. military. In a major speech on national security during the 2016 presidential campaign, then-candidate Trump called for significant increases in the military and promised to "submit a new budget to rebuild our military." Specifically, he called for a Navy of 350 ships, an active-duty Army of 540,000 soldiers, a Marine Corps of 36 active component infantry battalions, and an Air Force with 1,200 active component fighters.[1] The Navy later refined this goal to 355 ships, and the Air Force broadened its target to 386 squadrons overall.

With the help of two budget deals that raised the level of the budget caps imposed by the BCA, the defense budget grew by 12.7 percent, adjusting for inflation, from FY 2016 through the high reached in FY 2019. Despite this budget increase and the Trump administration's desire for a larger force, the size of the military did not grow in proportion to the budget. From FY 2016 to FY 2019, the number of ships in the Navy grew by 5.5 percent, the number of active-duty soldiers in the Army grew by 1.9 percent, the number of Marine Corps infantry battalions did not change, and the number of aircraft in the Air Force inventory fell by 0.1 percent.

In its FY 2021 budget request, the Department of Defense (DoD) all but abandoned its plans to grow. The Navy reversed its plans to extend the life of existing destroyers, which was key to reaching 355 ships by FY 2034; the Marine Corps announced plans to eliminate major parts of its force structure; and the Air Force never submitted a budget aligned to its 386-squadron goal. With a five-year budget projection that is essentially flat with inflation, the DoD is instead looking for efficiency savings and reforms to free up funds within its budget to accommodate growing operation and sustainment costs for existing forces and lagging modernization needs.

None of this is new or unexpected, nor is it the result of any recent changes in policies or priorities within DoD. Since the late 1990s, the trend lines for the defense budget and the size of the force have gradually grown apart—a trend that was exacerbated in the budget buildup after 9/11, as shown in Figures 1–3. The exceptions to this have been the Marine Corps active and reserve components and the Air Force guard and reserve components. There are many reasons larger budgets have not led to a larger active-duty force since the post-9/11 buildup, including the increasing sophistication and costs of new weapons needed to keep pace with advancing threats and the growing costs of military personnel and force structure.

Like previous strategies, the 2018 *National Defense Strategy* (NDS) continues the focus on modernizing capabilities and the personnel system. It warns of a more "lethal and disruptive battlefield, combined across domains, and conducted at increasing speed and reach" and that "we cannot expect success fighting tomorrow's conflicts with yesterday's weapons or equipment." It goes on to note that modernization also "requires change in the ways we organize and employ forces" and "innovative operational concepts." Among the key capabilities it cites as necessary to maintain a competitive advantage in the future are intelligence, surveillance, and reconnaissance (ISR) systems and advanced autonomous systems.[2]

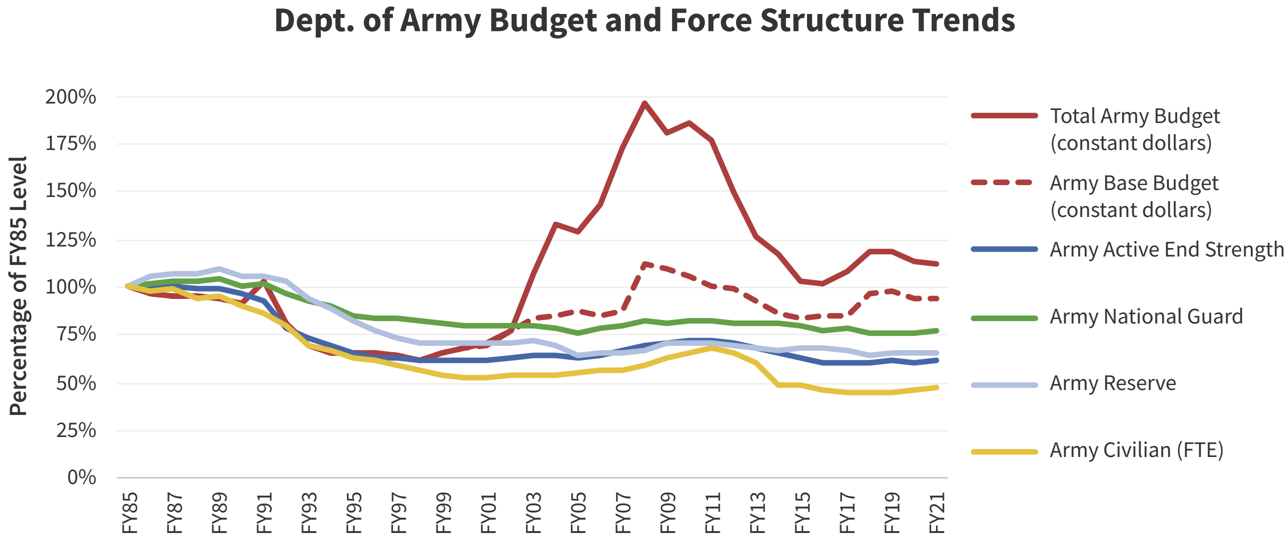
The NDS and the military services' subsequent implementation plans make clear that the future warfighting environment requires increased range and persistence—capabilities that are well suited for remotely crewed systems.[3] The Marine Corps' *Force Design 2030*, for example, says that (among other deficiencies) the Marine Corps currently lacks sufficient "high-endurance, long-range unmanned systems," and it is divesting traditional elements of its force structure, such as tank battalions, to fund these new systems.[4] The Navy is also moving toward more remotely operated systems with plans in the FY 2021 budget request to buy a total of 11 medium and large remotely crewed surface vessels and 6 extra-large remotely crewed undersea vessels through FY 2025, although these vessels do not count toward its total ship count metric.[5] More recently, former secretary of defense Mark Esper announced plans for the Navy to field 140 to 240 remotely crewed and optionally crewed surface and subsurface vessels over the next 30 years, comprising more than 25 percent of the total force.[6]

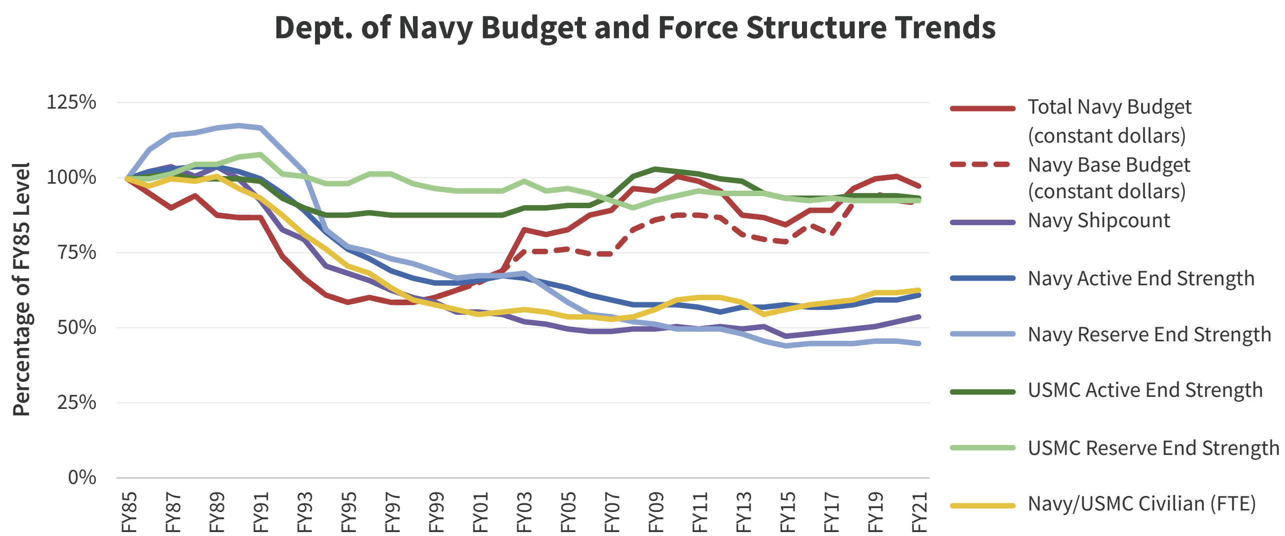
For its part, the Air Force has incorporated remotely piloted aircraft (RPAs) into its force structure in recent decades more out of operational necessity than strategic planning. While the Air Force experimented with RPAs as far back as World War II (while still part of the Army Air Corps) and classified drones played prominent roles in conducting missions for the Air Force and National Reconnaissance Office throughout the Cold War, RPAs did not become a major component of the Air Force's overall force structure until the 2000s.[7] As noted by former defense secretary Robert Gates in his memoir, the service was initially slow to embrace the MQ-1 Predator and increase the number of aircraft, ground control stations, and aircrews needed for operations in Iraq and Afghanistan.[8] But the service has now accepted RPAs as a permanent part of its force structure, and it is focusing on efforts to team RPAs with crewed aircraft and to develop low-cost attritable aircraft, such as the XQ-58A Valkyrie.[9]

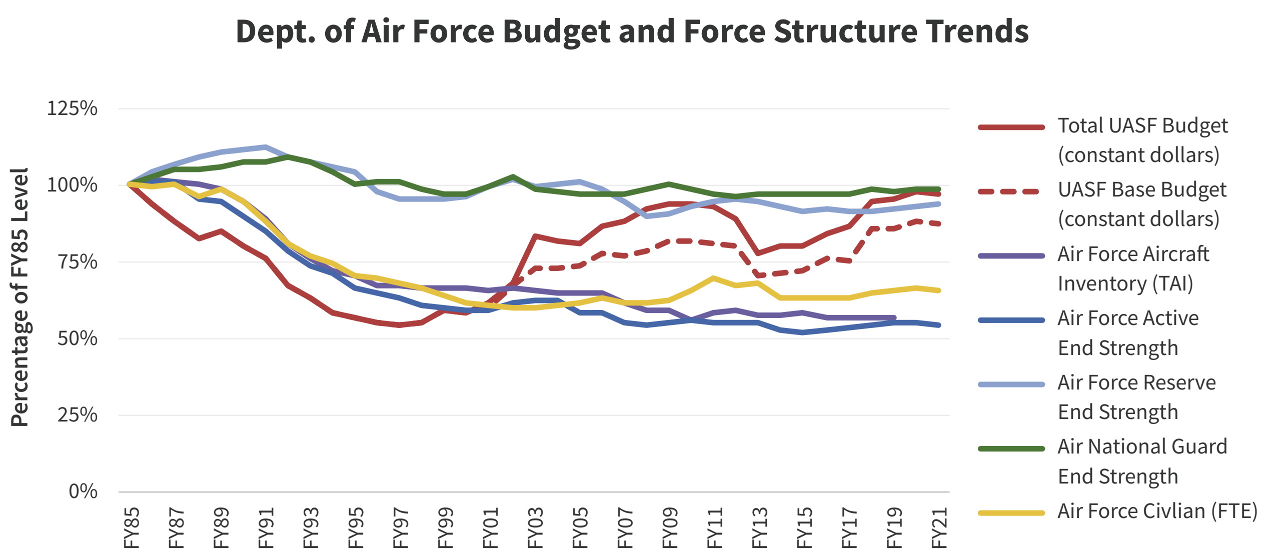
The combination of budget constraints and an increasing demand for remotely crewed systems creates an opportunity to break the cycle of growing budgets and declining force structure illustrated in Figures 1–3. However, remotely crewed systems do not directly translate into lower costs if they are staffed and operated in the same way crewed systems are traditionally staffed and operated. One of the keys to breaking the cycle of growing budgets and declining force structure is to reduce personnel requirements and fully leverage the potential of these systems to augment and enhance overall U.S. military capabilities and force structure.

This brief builds on a separate CSIS report that explores the long-term trends in personnel costs, growth in the cost per person in the military, and the key drivers behind this growth. The purpose of this study is to examine ways in which remotely crewed systems can help the military balance the trade-offs that resource constraints require among force structure, investment, and readiness. It focuses specifically on experiences to date with RPAs as compared to crewed aircraft, including the share of aircraft operating costs attributed to military and civilian personnel and the utilization rates of different platforms. The report also examines current practices for training, personnel, and operations for RPAs and how these practices have evolved over time. Based on these findings, the report makes recommendations for how the lessons learned from RPAs can be applied to remotely crewed systems in other mission areas and domains going forward.

Figures 1–3: U.S. Military Budget and Force Structure Levels by Department Relative to FY 1985







Source: Author's own compilation based on multiple sources.

COSTS AND UTILIZATION OF RPAS VERSUS CREWED AIRCRAFT

One of the promises of remotely crewed systems is that they can serve as a force multiplier for the military, either allowing it to increase force structure without a proportionate increase in personnel or to reduce personnel without cutting overall force structure. In theory, remotely crewed systems can allow the military to substitute technology for labor—a trade that becomes more favorable as labor costs grow larger and technology costs decline. However, the data over the past two decades show that as remotely crewed systems have been adopted into the military in limited mission areas, there has not been a concomitant decline in the number of personnel used for these missions.

Within the U.S. military, remotely crewed systems have made the most inroads in the airborne intelligence, surveillance, and reconnaissance (AISR) mission area, particularly in the Air Force.[10] This section looks at the Air Force AISR mission area to see what has changed as more RPAs have been adopted into the force structure. The main RPAs in the Air Force inventory examined in this analysis are the MQ-1 Reaper, MQ-9 Predator, and RQ-4 Global Hawk.[11] Other classified systems, such as the RQ-170 Sentinel, have been acknowledged, but data for these systems are not available for analysis.[12]

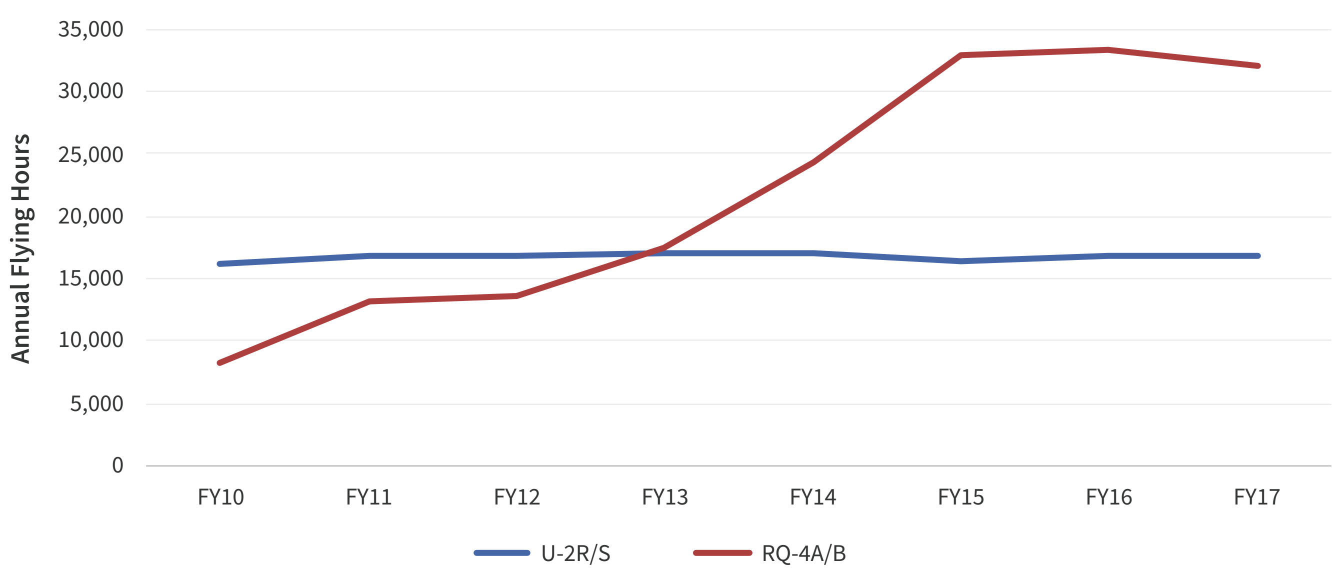
COMPARING UTILIZATION

One of the most notable trends in the data is that as remotely crewed AISR platforms were introduced into the Air Force inventory in large numbers, they did not directly substitute for the hours being flown by crewed AISR aircraft. For example, the RQ-4 and U-2 are both high-altitude ISR platforms with many overlapping capabilities. While they are not perfect substitutes, one would expect that the introduction of the RQ-4 would offset some of the missions and hours being flown by the U-2. However, from FY 2010 through FY 2017 the U-2 fleet of just over 30 aircraft held steady at roughly 16,000 to 17,000 flying hours per year as the RQ-4 entered the force in larger numbers. By FY 2015, the RQ-4 fleet of 37 aircraft had increased its operational tempo to more than 32,000 hours per year without a commensurate decline in U-2 operations, as shown in Figure 4.

The adoption of the MQ-1 and later the MQ-9 for medium-altitude AISR missions shows a similar trend. These systems were primarily fielded to address key shortfalls in AISR capabilities and capacity for ongoing operations in Iraq and Afghanistan. The annual flying hours for each of these platforms, shown in Figure 5, far exceeded the flying hours for other AISR platforms. This demand was initially driven by the surge of forces into Iraq and Afghanistan, but it quickly became part of steady-state operations for the Air Force. As the MQ-9 began to replace the MQ-1, the total flying hours for the combined fleet continued to climb, reaching a total of 385,000 hours in FY 2017—roughly six times as many hours as all crewed AISR platforms combined.[13]

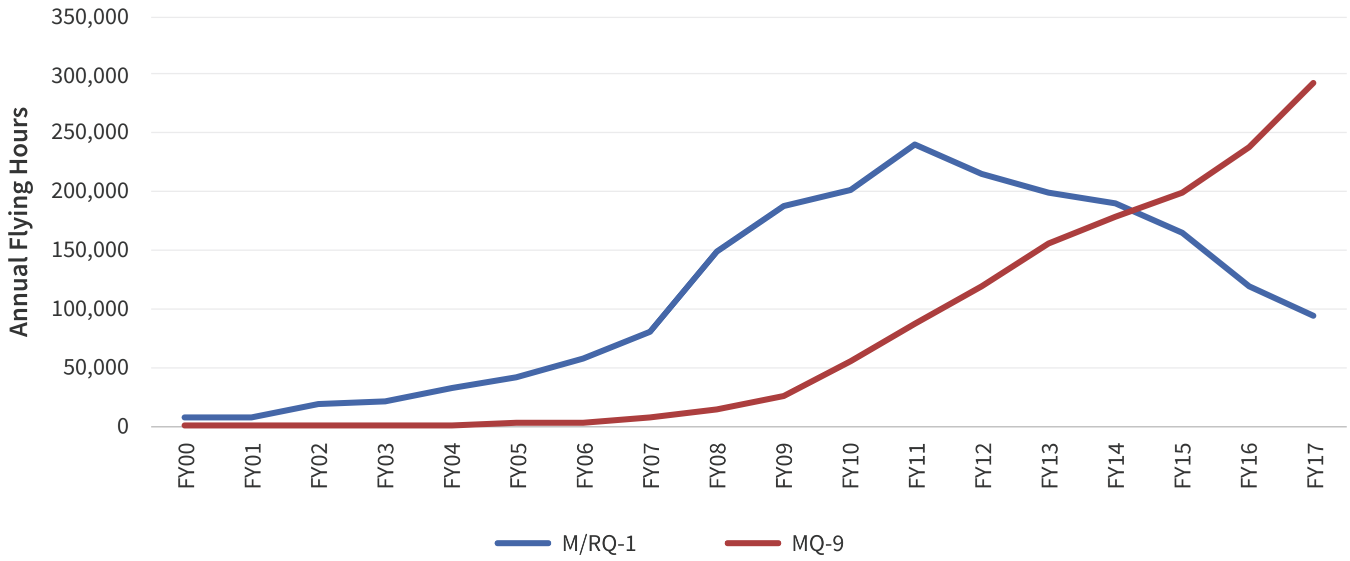
One of the reasons RPAs have logged so many more hours than crewed aircraft is their higher utilization rate. The MQ-1, for example, peaked at a rate of more than 1,300 hours

Figure 4: U-2 versus RQ-4 Annual Flying Hours



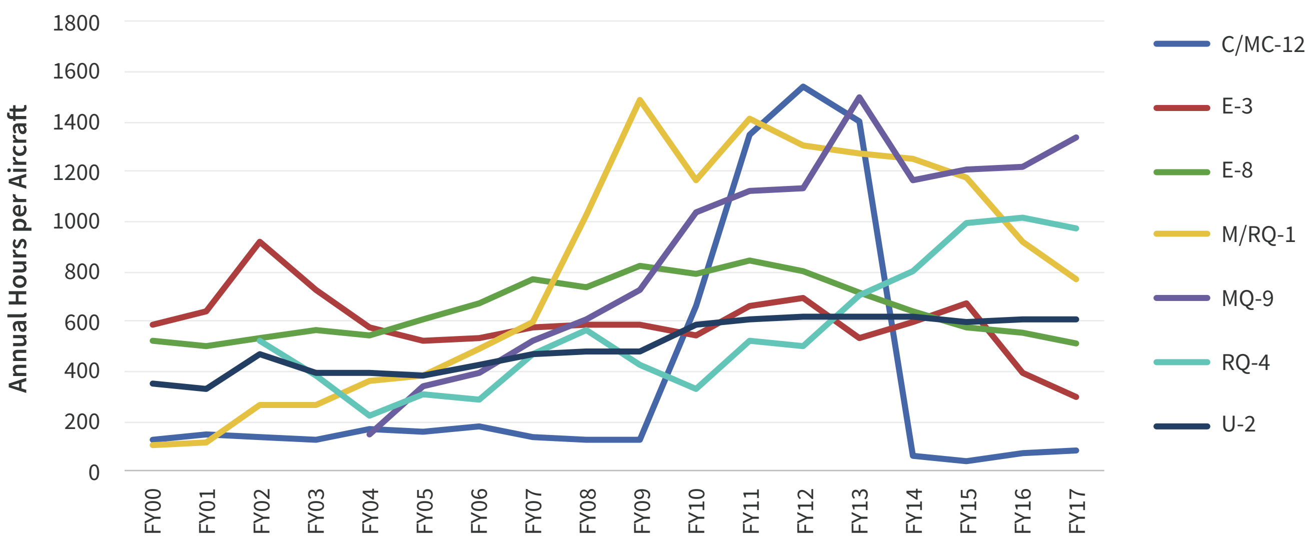
Source: Air Force Total Ownership Cost Database.

Figure 5: M/RQ-1 and MQ-9 Annual Flying Hours



Source: Air Force Total Ownership Cost Database.

Figure 6: Annual Hours per Aircraft for AISR Platforms



Source: Air Force Total Ownership Cost Database.

annually per aircraft before the Air Force began replacing it with the more capable MQ-9, which itself peaked at just short of 1,500 hours annually per aircraft. Likewise, the RQ-4 has grown to nearly 1,000 flying hours per aircraft annually. This is significantly more than crewed AISR platforms, which have typically hovered in the range of 400 to 800 annual hours per aircraft, as shown in Figure 6. The exception for crewed aircraft is the C/MC-12, which surged to more than 1,500 hours per aircraft annually for a few years.

The data indicate that remotely piloted AISR aircraft have not reduced demand for crewed aircraft. Rather, these new aircraft have been used to satisfy previously unmet demand that existing crewed aircraft could not surge to meet. Thus, remotely crewed AISR units and their associated personnel have been additive to force structure and costs rather substituting or replacing crewed AISR platforms and personnel.

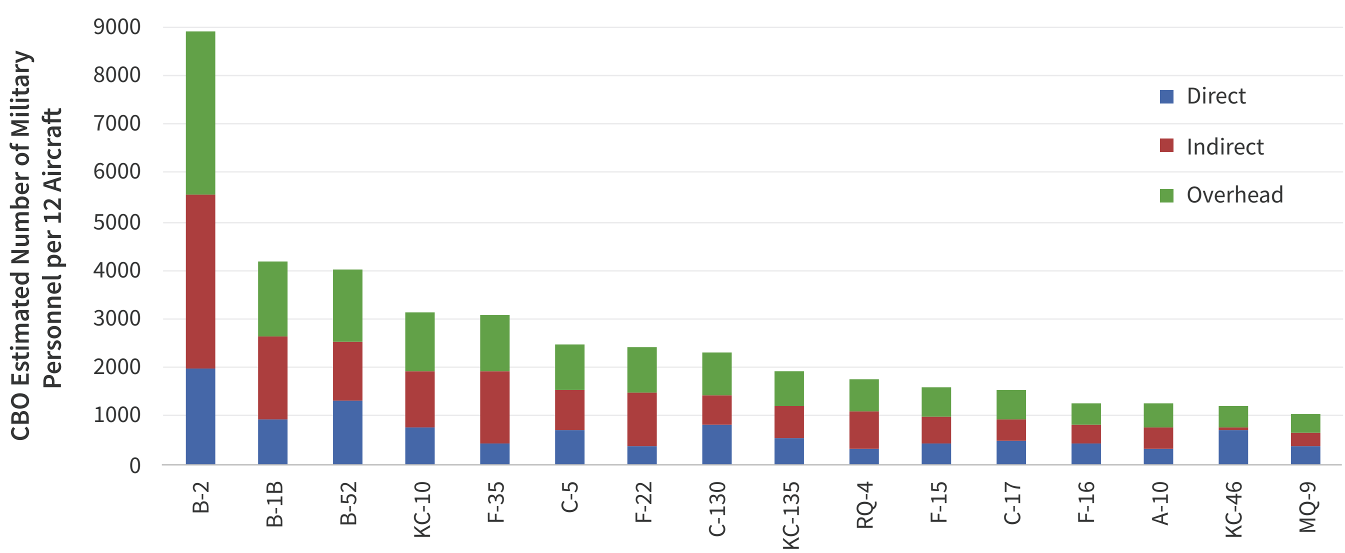
COMPARING COSTS

The data available on personnel costs and numbers also reveal that while RPAs have been flown at a higher rate (as measured by the number of flying hours per aircraft annually), their staffing levels are similar to other types of crewed aircraft. In a periodic report on military force structure, the Congressional Budget Office (CBO) estimates the total number of military personnel associated with different types of Air Force aircraft, as shown in Figure 7.[14] To allow for comparisons across aircraft types, the CBO uses a common standard of 12 aircraft per unit, and it includes direct, indirect, and overhead personnel associated with these aircraft.[15] The only AISR aircraft included in the CBO analysis are the RQ-4 and MQ-9, so direct comparisons of crewed versus remotely crewed AISR aircraft are not possible. But the data reveal that personnel requirements for the RQ-4 and MQ-9 are in the middle and lower end of the range, respectively, when compared with crewed bombers, fighters, and mobility aircraft. Notably, the CBO data only include staffing levels for military personnel and do not include civilian or contractor support personnel.

Additional data on personnel costs can be derived from the Air Force Total Ownership Cost (AFTOC) database. An extraction of this data for the years FY 2010 through FY 2017 was analyzed to determine the average annual costs of military and civilian personnel per aircraft and per flying hour to compare across different aircraft types. The AFTOC data include both crewed aircraft and RPAs of various types. It reveals that crewed AISR aircraft, namely the E-8, E-3, RC-135, and OC-135B, are among the most expensive for personnel on both a per-plane and per-flying-hour basis, as shown in Figures 8 and 9. Remotely piloted AISR aircraft, in contrast, have relatively lower personnel costs than other AISR platforms. On a per plane basis, RPA personnel costs are roughly in the same range as fighter and mobility platforms. For example, the MQ-1's personnel costs are roughly equivalent to an F-16 on a per-aircraft basis, and the MQ-9's personnel costs are similar to an F-22. RPA personnel costs are considerably lower on a per-flying-hour basis because these aircraft tend to spend significantly more time in the air, thus increasing the denominator (flying hours) while personnel costs (the numerator) are largely fixed with respect to flying hours.

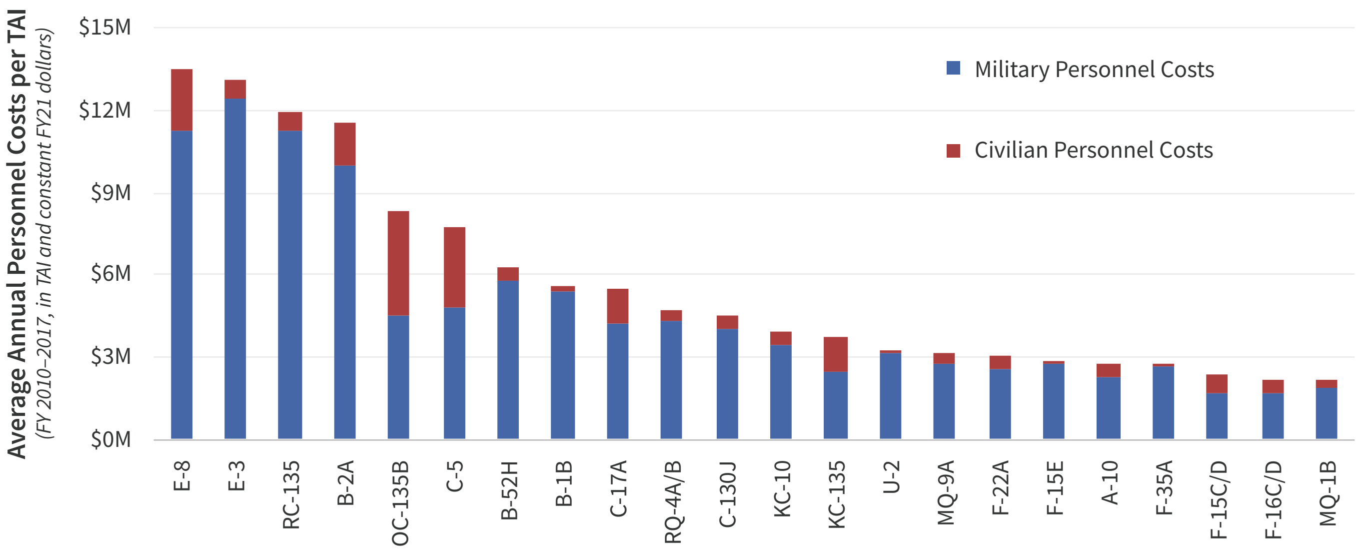
Importantly, both the CBO and AFTOC data do not include the downstream costs of processing, exploitation, and dissemination (PED) of the ISR data obtained by these aircraft. The larger amount of ISR data collected from RPAs translates into higher PED requirements, but if the same sensors were flown the same amount of time for the same missions using crewed aircraft instead, they would generate the same PED requirements. PED personnel requirements are a function of the mission and volume of data collected and not the crewed status of the platform collecting the data. Thus, PED costs should not factor into the comparison of personnel requirements for crewed versus remotely crewed platforms—it is a function of ISR demand. Separate studies have analyzed how PED personnel requirements can be reduced using machine learning and artificial intelligence to augment or replace human labor in the PED process, but this discussion is beyond the scope of this brief.[16]

Figure 7: CBO Estimates of Military Personnel Requirements for Air Force Aircraft



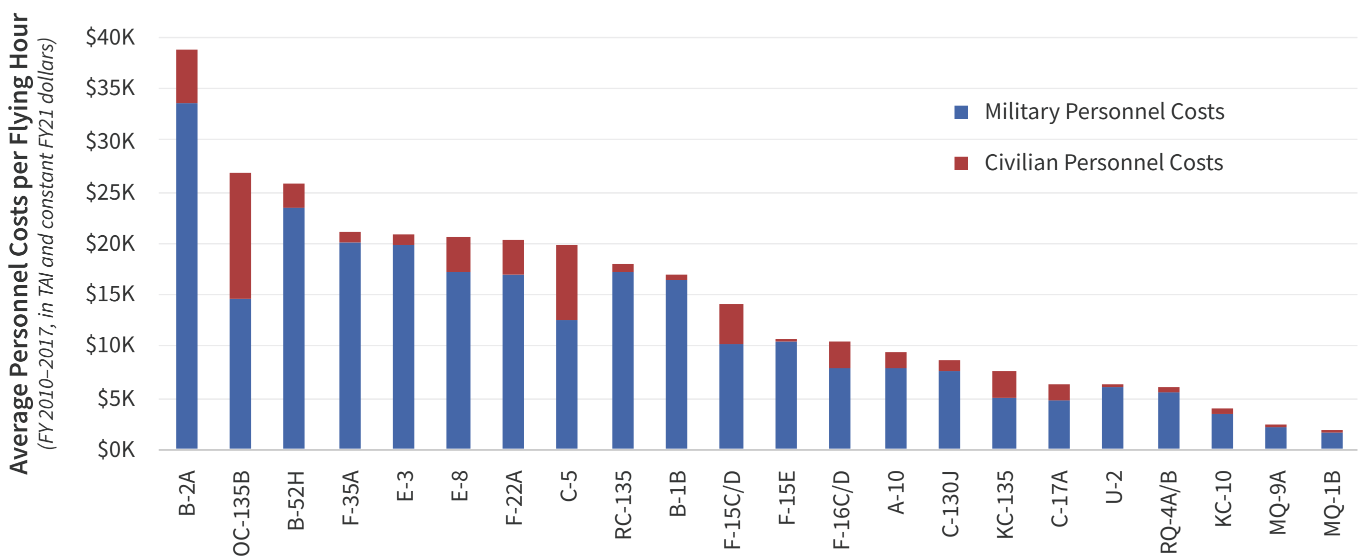
Source: Congressional Budget Office, *The U.S. Military's Force Structure: Fiscal Year 2019 Update to Personnel Numbers and Costs*, August 15, 2018, https://www.cbo.gov/publication/54136.

Figure 8: Personnel Costs per Aircraft (TAI)



Source: Air Force Total Ownership Cost Database.

Figure 9: Personnel Costs per Flying Hour



Source: Air Force Total Ownership Cost Database.

The cost and utilization data analyzed for RPAs point to two key findings. First, remotely crewed systems do not necessarily lead to savings if they are used in missions where there is already a high level of demand for steady-state operations. And relatedly, remotely crewed systems have demonstrated an ability to support significantly higher utilization rates (measured in the annual hours of operation per platform) than crewed systems. But this higher utilization rate can be both a blessing and a curse. It means that a smaller number of remotely crewed platforms can provide the same effective capacity as a larger number of crewed platforms. But it also makes it tempting for combatant commanders to request a consistently higher operational tempo even during peacetime operations. This can ultimately stress platforms and personnel and undermine potential savings.

CURRENT PRACTICE FOR TRAINING, PERSONNEL, AND OPERATIONS

As the former commander of the Air Force's Air Combat Command, General Herbert "Hawk" Carlisle, noted in 2016, the combatant commands have generated an "insatiable demand" for RPAs.[17] In attempting to meet this demand and rapidly stand-up new elements of force structure, the Air Force made a number of policy choices over the past two decades in how it manages and organizes the training and operations of RPAs. This chapter examines current policies and processes used for training, personnel development, and operations and how they have evolved over time.

TRAINING

As the Air Force began fielding remotely piloted AISR platforms in significant numbers, it copied many of its training and personnel models from crewed aircraft units. The initial approach used for producing pilots for RPAs was to transfer experienced pilots from crewed aircraft squadrons. This allowed for a relatively short three-month initial qualification training period, and it gave leaders more confidence in putting these newly retrained pilots directly into a "near-solo combat environment" without a more experienced flight lead accompanying them on missions. However, this approach proved to be insufficient to meet the rapid growth in the number of MQ-1 combat lines and the resulting demand for RPA pilots.[18]

In 2010, the Air Force changed course and created a dedicated career field for RPA pilots, known as Air Force Specialty Code 18X, and a separate training pipeline for these pilots. One of the motivators for this change was to reduce costs. By some estimates, the RPA pilot training pipeline costs 95 percent less per pilot than the traditional pilot training used for crewed aircraft.[19] RPA pilots now begin with an initial flight training class tailored for remote systems and then progress to a separate undergraduate pilot training course before transitioning to platform-specific training and mission qualification training.[20] While this training process allows for the development of a cadre of dedicated RPA pilots, it largely mirrors the traditional pilot training process in the Air Force (albeit with simulators). Moreover, it requires RPA pilots to be officers, just as the Air Force only allows officers to pilot crewed aircraft. Sensor operators for RPAs in the Air Force have a similar four-step training process, but these positions are filled by enlisted personnel.[21]

One of the distinctive attributes of RPAs is that units routinely conduct in-garrison combat operations. Crews in the Mission Control Element engage in combat operations from their home station, rotating in and out of duty during the week and returning to their home and families after each shift. In-garrison operations are not unique to RPAs. Space operators (13S) and missileers (13N), for example, have some of the same challenges trying to maintain a constant readiness while conducting in-garrison operations.

As the demand for AISR grew due to ongoing operations in Iraq, Afghanistan, and Syria, this meant that units were expected to maintain a near-constant level of readiness without regular periods for recovery, training, and leave. For MQ-1 and MQ-9 crews, this relentless pressure led to training issues. The focus of units and personnel was persistently on meeting combat mission demands, leaving little time for mission qualification training, upgrade training, professional military education, and leave. In response, the Air Force approved in January 2017 a combat-to-dwell policy for RPA units that allows time to focus on training while not simultaneously conducting combat operations.[22]

PERSONNEL

The Air Force has consistently experienced difficulties recruiting and retaining aircrews, including RPA pilots and sensor operators. As the Government Accountability Office (GAO) noted in a recent report, from 2015 through 2019 the Air Force only met 95 percent of its accession target for RPA pilots and 88 percent for sensor operators.[23] As of September 2019, 20 percent of the authorized RPA pilot positions were unfilled, and 28 percent of the sensor operator positions were unfilled.[24]

The Air Force has restricted pilot positions to officers since 1948, and this restriction extends to Group 4/5 RPAs, such as the MQ-1, MQ-9, and RQ-4.[25] The Army, however, has a long history of using enlisted personnel, specifically warrant officers, as pilots. As the Army fielded its own fleet of MQ-1s, it began using enlisted "operators" to pilot these aircraft. Despite operating similar equipment, the difference in Army and Air Force pilot requirements has been justified more by the scope and complexity of the mission sets they each perform than the aircraft they fly. For example, the Army tends to fly its MQ-1s for more tactically focused missions in regionally isolated operations, whereas the Air Force tends to operate its aircraft over wider regions that can include passing through uncontrolled airspace.[26] The Army's MQ-1C Gray Eagle fleet also includes a higher degree of autonomy, using point and click control instead of stick and throttle and an automatic takeoff and landing system.[27]

Congress forced the issue of using enlisted Air Force pilots for RPAs in the FY 2017 National Defense Authorization Act. In this legislation, Congress mandated that the Air Force transition to "an organizational model for all Air Force remotely piloted aircraft that uses a significant number of enlisted personnel as operators of such aircraft rather than officers only."[28] The Air Force opened training opportunities for RQ-4 pilots to enlisted servicemembers, and it began training its first cohort of enlisted pilots in 2017.[29] However, the Air Force has not yet announced plans to open MQ-9 pilot opportunities to enlisted personnel, which comprise the vast majority of positions that remain unfilled.

OPERATIONS

In a 2009 publication, the Air Force stated that "similar personnel models used for manned platforms with regard to duty day and levels of supervision are applicable to UAS [Unmanned Aircraft System]." This acknowledges that the Air Force built its RPA career field and squadrons assuming they would operate essentially the same way traditional crewed aircraft squadrons operate. The same publication went on to note that, "the USAF used these models to determine the manpower required to achieve their goals."[30] Again, the crewed aircraft operations mindset is reflected in how the Air Force organizes and staffs its RPA squadrons today.

A typical MQ-1 or MQ-9 combat line (previously known as a combat air patrol, or CAP) consists of four aircraft and requires some 49 people in the mission control element and 59 people in the forward-deployed launch and recovery element, as shown in Table 1. These direct unit personnel are sufficient to support 24/7 operations with at least one aircraft over a target area at all times on a sustainable basis.[31]

Current staffing levels for active-duty units require an effective crew ratio of 10 to 1 in the mission control element, meaning 10 pilots and 10 sensor operators are needed to keep a single MQ-1/MQ-9 combat line in the air 24/7. This is due to time limitations and rest requirements for the crew and the desire to maintain at least one pilot and sensor operator in control of each platform at all times. Because of the time latency involved in satellite communications signals, manual takeoff and landing of RPAs at forward locations cannot be conducted by pilots in the mission control element. For these reasons, an additional three pilots and three sensor operators are needed in the launch and recovery element for each combat line for line-of-sight control during takeoff and landing, making the total crew ratio 13 to 1. The RQ-4 uses a similar structure, with split operations between a mission control element in the United States and a forward-deployed launch and recovery element.[32] However, the RQ-4 reportedly uses a crew ratio of 15 to 1 at the mission control element.[33]

For a typical remotely piloted AISR mission, the aircraft may stay airborne for 16 hours or more. During this time, the pilot, sensor operators, and mission coordinators at the mission control element would transfer control of the aircraft across multiple shifts. Simultaneously, the launch and recovery element would maintain one pilot and one sensor operator on standby rotation throughout the duration of the mission in case the aircraft needs to land early or a fresh aircraft needs to be launched. Consolidating remote operations in the mission control element means that fewer personnel need to be deployed overseas to support operations. But split operations also means that at any given moment in a mission, at least two pilots and sensor operators are on duty to maintain just one aircraft on station.

The experiences gained from the use of RPAs for AISR missions can be instructive for how remotely crewed systems can be expanded to other domains and mission areas. Important lessons can be learned from the evolution in RPA pilot training, how the RPA career field and personnel are managed, and the way RPA units are structured and operated. Each of these areas provides

Table 1: Staffing for a Typical MQ-1 or MQ-9 Combat Line

	Mission Control Element	Launch and Recovery Element	Total
Pilots	10	3	**13**
Sensor Operators	10	3	**13**
Maintenance	8	53	**61**
Mission Coordinators	5		**5**
Leadership	2		**2**
Administrative	14		**14**
Total	***49***	***59***	**108**

Source: Menthe et al., *The Future of Air Force Motion Imagery Exploitation*, 5.

valuable insights into what works, what has not worked, and pitfalls that should be avoided in the future.

IMPLICATIONS FOR THE FUTURE FORCE

BENDING THE IRON TRIANGLE

One of the fundamental roles of peacetime defense strategy is to help guide trade-off decisions among force structure, readiness, and investment—what Deputy Secretary of Defense Kath Hicks has termed the "iron triangle of painful tradeoffs."[34] While an unconstrained, "more of everything" approach may sound appealing, in practice one can never have unlimited amounts in all three areas. As Bernard Brodie wrote in the late 1950s, "we can never be rich enough to afford all the equipment we could legitimately use for our security, and we must therefore make painful choices in which the major consideration is to get the most security for the dollar."[35]

Remotely crewed systems hold the promise of easing—but not eliminating—these painful strategic trade-offs in two main ways. They can substitute technology for labor to reduce overall personnel requirements, and they can extend force structure (capacity) without extending peacetime operating costs. If these advantages can be realized, remotely crewed systems could help bend, if not break, the cycle of growing budgets and declining force structure described in the opening of this brief.

However, the previous chapters have shown that remotely piloted AISR aircraft have not demonstrated significant reductions in overall personnel or operating costs. Experiences to date indicate that this is due to the high level of preexisting unmet demand for the missions RPAs currently support. The data show that as overall AISR capacity has grown with the addition of RPAs in large numbers, this additional capacity has been immediately and continuously consumed—taxing both the platforms and the people that operate them. Moreover, the additional capabilities provided by RPAs, such as the ability to conduct 24/7 wide-area surveillance, has generated even more demand for the intelligence products they provide. Instead of substituting for crewed AISR aircraft or providing latent surge capacity, the MQ-1, MQ-9, and RQ-4 have been used to assuage insatiable demand for ISR among the combatant commands.

The same may not be true for other mission areas or in other domains where the use of remotely crewed systems is likely to expand. The military services are exploring the use of remotely crewed aircraft for a wide range of missions, including aerial refueling, airlift, air superiority, and missile defense. In the ground domain, the Army has experimented with uncrewed ground vehicles using various levels of autonomy for missions ranging from logistics and resupply to scouting and fires. In the maritime domain, the Navy is developing remotely crewed ships and submarines as a more cost-effective way to expand its missile strike capacity and to enable more dispersed operations. The steady-state demand for operations may not be as high in some of these areas as it has been for AISR, which could create opportunities to realize the cost benefits of remotely crewed systems.

RECOMMENDATIONS

Given the long-term trends of rising costs and shrinking force structure, the U.S. military should explore ways to use remotely crewed systems to augment—and in some cases replace—traditionally crewed units and force structure across domains. However, for remotely crewed systems to become an affordable and scalable alternative to crewed systems, several issues must be addressed. The recommendations below are drawn from the data analyzed as part of this study and the best practices and lessons learned from the buildup of RPA units, personnel, and operations over the past two decades.

Create Separate Training Pipelines for Remotely Crewed Systems

One of the early lessons learned from the Air Force's experience in expanding the fleet of MQ-1s is that merely transferring pilots from crewed aircraft to RPAs is both cost inefficient and difficult to scale. The Air Force could not transition pilots fast enough to meet RPA demands without creating even greater shortfalls in pilots for crewed aircraft. A separate training pipeline for RPAs proved to be much less expensive and more scalable to accommodate the surge in demand for RPA pilots.

As remotely crewed systems enter the force in larger numbers in other areas, the services should heed this lesson and begin developing separate training curricula and processes tailored to remotely crewed systems. This is especially important for the Navy, where the most recent long-range plan projects that more than a quarter of the fleet will be remotely operated ships within the next 30 years. While remote operators can certainly benefit from the wisdom and experience of crewed operators, the training provided to remote operators does not need to mirror traditional training. Moreover, the tactics, techniques, and procedures used for crewed operations should not constrain the development of new concepts of operations for remotely crewed systems.

Create Separate Career Fields for Remote Operators

In conjunction with creating a separate training pipeline, the Air Force also ended up creating a separate career field designation for RPA pilots. This proved necessary because pilots progressing through RPA training did not attain the same skills as traditional crewed pilots, and thus the two were not interchangeable. Creating a distinct career field for RPA pilots had the added benefit of making it possible for the Air Force to begin developing a dedicated cadre of remote operators, which creates more opportunities for professional development and advancement within the field. As remotely crewed systems become a larger component of the military, the services should use the creation of a separate career field for remote operators as a way to allow these personnel to deepen their domain expertise and begin to explore new concepts of operation and doctrine specific to remotely crewed systems.

Reconsider the Officer-Enlisted Divide

Differences in how the Army and Air Force assign pilots and sensor operators for RPAs raise questions about how the officer-enlisted divide should be applied to remotely crewed systems more generally. Each of the services have their own cultural traditions for which responsibilities and authorities are assigned to officers, warrant officers, senior non-commissioned officers, and junior enlisted. By default, these traditions are likely to carry over to remotely crewed systems and the personnel that support them.

The rising costs of military personnel, the increasing levels of automation in modern weapon systems, and the use of more remotely crewed systems create a compelling opportunity to reconsider the officer-enlisted divide within each of the services. As more remotely crewed systems are fielded and new career fields are created to support them, the services should study alternatives for how these systems can be most effectively and efficiently staffed. The functions and skills needed for various positions in crewed platforms—including operators, maintainers, and other unit personnel—may not always translate into similar functions and skills for remotely crewed platforms. The services should carefully evaluate and match job functions, skill levels, and responsibilities according to what is optimal for remotely crewed systems and not automatically default to service traditions and culture.

Explore New Models for In-Garrison Operations and Training

A potential advantage of remotely crewed systems is that routine operator training can be conducted almost entirely using simulators, which reduces costs and the wear on platforms. Some platforms could even (in theory) be stored and only taken out when necessary for testing and maintenance—much like war reserve matériel. With limited day-to-day operations and extensive simulator-based training, these types of platforms may be well suited for placement in the guard or reserve rather than the active component, which can further reduce peacetime costs.

However, many remotely crewed systems will be needed to support day-to-day peacetime activities, such as presence missions to reassure allies and partners, demonstrations of capabilities to bolster deterrence, and routine intelligence collection. They may also need to occasionally conduct real-world training exercises with crewed units to practice interoperability and teaming. The anticipated level of steady-state peacetime demand for operations should therefore be a driving factor in developing new models for in-garrison operations and training and the division of units among the active and reserve components.

The Air Force's experience with in-garrison operations for RPAs is instructive but incomplete. One of the lessons learned is that for high-demand assets, such as AISR aircraft, the operational tempo (OPTEMPO) may not easily afford opportunities for upgrade training and career development. Balancing real-world mission demands with the personal and professional needs of servicemembers can be especially difficult for high OPTEMPO in-garrison operations. The services may be able to adapt operating models from other types of units that have a longer history of in-garrison operations, such as space operators and missileers. However, there remain significant gaps in knowledge for remotely crewed systems where the platforms are not in high demand for steady-state peacetime operations. As these types of remotely crewed systems begin to emerge, the services should conduct controlled experiments to iteratively develop new models for training and operations, including how these units can be optimally staffed, structured, and sustained.

Explore the Use of Automation and Artificial Intelligence for Maintenance

Maintenance is a personnel-intensive activity for both crewed and remotely crewed systems. As previously shown in Table 1, more than half of the personnel in a typical MQ-1/MQ-9 combat line are maintainers. Because maintenance of a platform must be conducted where the platform is based rather than where it is controlled, remotely crewed systems will continue to need a deployable launch and recovery element for

Airmen assigned to the 319th Aircraft Maintenance Squadron work together to perform regular preflight maintenance for an RQ-4 Global Hawk on Grand Forks Air Force Base, N.D.

Source: U.S. Air Force photo by Senior Airman Elora J. McCutcheon.

maintenance. It is possible that some remotely crewed systems can be operated with lower margins of safety if a malfunction does not pose a serious risk to loss of life or property. For example, a low-cost remotely crewed ground vehicle whose engine stalls while on a mission may be of low consequence. But this is likely to be the exception rather than the rule because many of the remotely crewed systems being developed or considered are just as mission critical as their crewed counterparts and must be maintained to similar safety standards.

Predictive analytics and artificial intelligence can be used to better optimize maintenance schedules to reduce overall maintenance requirements. Robotic servicing could potentially be used to conduct some routine maintenance activities (and reduce staffing levels), but platforms may need to be designed with robotic servicing in mind. The services should explore options to reduce the amount of touch labor required in maintaining systems, including system designs and architectures that are optimized for easy maintenance. Particular emphasis should be placed on using the large volumes of telemetry and system performance data generated by remotely crewed systems to better predict when components may fail. While much attention is paid to the potential of artificial intelligence to improve the operation of weapon systems, a more near-term and fruitful application of this technology may be to optimize the maintenance of these weapon systems.

Leverage Automation When a Human-in-the-Loop Is Not Needed

Increasing levels of automation are being incorporated into both crewed and remotely crewed systems across the military. For remotely crewed systems, automation can be an important tool for mission tasks where a human-in-the-loop is not needed or may be a disadvantage. The Army has significant experience using automatic takeoff and landing for its fleet of MQ-1s, but the Air Force has been slower to embrace this technology. If the Air Force fully adopted automatic takeoff and landing systems and remote taxi operations, it could eliminate the need for pilots and sensor operators in the launch and recovery element.

Increasing levels of automation can help reduce the workload on pilots and sensor operators throughout all phases of flight. For example, point-and-click controls (rather than stick and throttle controls) can allow the pilot and sensor operator roles to be combined. Moreover, increasing levels of automation can allow one operator to control multiple aircraft simultaneously. But the current operational model for AISR aircraft mandates a one-to-one ratio of pilots and sensor operators to aircraft. This model does not take full advantage of the force multiplier effects remotely crewed systems can bring to the military. The services should be more forward leaning and adopt a one-to-many approach for operations where possible. This would enable better utilization of the most expensive and scale-limiting component of labor in remotely crewed systems: the operators.

Explore Lower Latency Communications When a Human-in-the-Loop Is Needed

While automation can help with many tasks where a human is not needed, many functions for remotely crewed systems will still require a human-in-the loop for the foreseeable future. For these types of operations, the communications link between the operator and platform is critical. A typical link to an RPA involves traveling by fiber from the mission control element to a satellite ground station near the region in which the aircraft is being flown.

The signal then travels up to a satellite in geostationary orbit 22,000 miles above the Earth and back down to the aircraft in flight. The time for a signal traveling at the speed of light to get up to a satellite in geostationary orbit and be retransmitted back down to an aircraft flying in the same region is roughly 270ms. This means that the roundtrip time for a signal to travel from a satellite ground station to an aircraft and back is 540ms—not including the terrestrial fiber component of the link between the satellite ground station and the mission control element where the operator resides. This latency is one of the main reasons that operators are needed locally in the launch and recovery element to land aircraft manually because it allows them to use direct line-of-sight communications with very little latency.

New satellite constellations being deployed in low Earth orbit (LEO) have much lower latency because they are physically closer to the Earth. Systems such as SpaceX's Starlink constellation are advertising roundtrip transmission times of as low as 20ms.[36] Equipping remotely crewed platforms with communication systems capable of using these emerging LEO constellations could reduce latency by roughly a half second roundtrip. To further reduce latency in the terrestrial fiber component of the communications pathway, the military could position mission control elements in regional bases around the global, such as Germany or Australia, that are near or adjacent to satellite ground stations. Reducing communications latency could allow more human-in-the-loop operations to be conducted from the mission control element and reduce the requirement for operators in the launch and recovery element.

Explore Alternative Organizations for Remotely Crewed Systems

Since the National Security Act of 1947 and the DoD Reorganization Act of 1958, the U.S. military has been structured as a matrix-managed organization under the military services and the combatant commands. The services organize, train, and equip military forces in their respective domains, while the combatant commands integrate and employ these forces in operations. Given this division of responsibilities, the services have wide latitude to organize internally in ways that enhance their ability to recruit, train, and innovate the forces and capabilities they provide to the combatant commands.

The military services tend to cluster units into groups according to how they are intended to be deployed. For example, the Army organizes itself around brigade combat teams and the Navy around carrier strike groups. Despite this organizational structure, units are often requested on an "à la carte" basis by the combatant commands according to operational constraints and external limits on the numbers of forces in-theater. This often means deploying only a certain type of battalion from a brigade combat team or only a few ships out of a carrier strike group.

Recognizing this tendency toward the ad hoc employment of units, the services should examine the potential benefits of creating separate organizational structures for remotely crewed systems. The Air Force has largely interspersed its MQ-1, MQ-9, and RQ-4 squadrons among wings and Numbered Air Forces that also house crewed aircraft squadrons. For example, the 432nd Wing—the first wing in the Air Force composed entirely of RPA—is part of the 15th Air Force, which also includes F-22, F-15E, E-8C JSTARS, and E-3 AWACS squadrons.[37] The risk in this approach is that the organizational dispersion of RPA units can inhibit the flow of best practices among squadrons, create barriers to building a coherent community of operators within the career field, and ultimately stifle career progression for remote operators if they are forced to compete with crewed system operators for higher levels of command.

The Air Force should consider combining RPA squadrons under dedicated wings and Numbered Air Forces and eventually creating a Major Command for RPAs. While the other services do not yet have as many remotely crewed units as the Air Force, they may want to begin experimenting with organizational structures to help alleviate some of the cultural challenges these systems may experience when integrated into the force in larger numbers.

FINAL THOUGHTS

Current defense strategy calls for forces that are longer range, have greater persistence, and are better suited to an operating environment that can rapidly vary from permissive to highly contested in all domains. This strategy requires a force that is larger than current budgets can sustain, and it needs a military that is more agile in how it organizes and employs forces to face challenges ranging from gray zone competition to high-end conflict. While strategy should drive budget decisions, resource constraints ultimately drive the need for strategy and the innovative technologies and concepts of operation that can bring strategy and budgets into alignment.

Remotely crewed systems have the potential to help provide the capabilities and capacity the U.S. military needs to execute the strategy in a budget constrained environment. But this potential cannot be achieved if remotely crewed systems are staffed and operated in the image of their crewed counterparts. Different approaches are needed for setting personnel requirements, conducting training and in-garrison operations, leveraging automation, and organizing units for success. Unlocking the full potential of remotely crewed systems is more a matter of policy innovation than technological innovation. ■

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Cover Photo: U.S. Air Force photo by Staff Sgt. Omari Bernard

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