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AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

UNINHABITED AIR VEHICLE

CRITICAL LEVERAGE SYSTEM FOR OUR NATION'S DEFENSE IN 2025

by

Thomas G. O'Reilly, Major, USAF

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Advisor: Major Andrew M. Beno

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Abstract

The Air Force 2025 was chartered at the direction of then Chief of Staff of the Air Force (CSAF) Gen Ronald R. Fogleman. A document that took a year to research and develop had to answer one question. "What capabilities should the USAF have in 2025 to help defend the nation". When 2025 was published in August 1996, it identified uninhabited air vehicles as one of 10 critical leverage systems crucial to the defense of our nation. This paper will discuss how the USAF has been responding in answering the proposed question and also its progress since the identification of these high leverage systems. This study will investigate whether or not the USAF is still committed in exploiting the uninhabited air vehicle systems addressed in Air Force 2025. This paper reviews the USAF 2025 plan and original tasking. There is also a brief background review on UAV development and missions that pave the way to the requirements of UCAVs. There is financial information from the Department of Defense agencies to show the USAF's progress in procuring this high leverage system. A look at world events and technology races was done to see if there were any major impacts that influenced the USAF to pursue this line of defense for our country. Finally, a look at possible consequences to our nation's defense are addressed should the USAF decide not to follow the 2025 plan recommendation to pursue the use of use UCAVs.

Chapter 1

Introduction

> *Power undirected by high purpose spells calamity; and high purpose by itself is utterly useless if the power to put it into effect is lacking.*
>
> —Theodore Roosevelt

This paper will pick up where the 2025 left off after it was released for distribution. It is nearing the three year point since the release of this highly intense study and we need to look at the progress the USAF has made in the areas the 2025 plan identified as some of its high leverage systems, in particular the Uninhabited Combat Air Vehicle (UCAV). An explanation on how this systems was identified as a high leverage system will be addressed in the next chapter.

Statement of the research question

Is the USAF still committed to exploit the uninhabited air vehicle systems addressed in the Air Force 2025? By the end of this paper, it will be clear whether or not the USAF is backing its words with actions.

Background on the subject

The 2025 program dates back to 1996 when Chief of Staff of the Air Force Gen Ronald R. Fogleman directed Air University to research and develop a document that

would answer one question. "What capabilities should the USAF have in the year 2025 to help defend the nation".[1] The subject of UAVs has been with the USAF dating back to the early days of WW II.[2] It seems it's has only been in times of crises that the emphasis of UAVs is pushed up to the top of DOD's priority lists. Chapter three looks deeper into the origins of UAVs because these unmanned resources set the stage on why UCAVs have become critical to our national defense.

Limitations of the Study

Because the USAF is in what one would call the preliminary stages of this subject, the availability of data is still in the developmental stages and difficult to acquire. As of the printing of this paper contract award for the development and flight test of UCAVs had not been awarded because of proprietary and disclosure rights. All available means have been exhausted in researching the most current data for this paper.

Definitions and Assumptions

Before launching into the narrative of this paper, it is necessary to clarify some definitions and assumptions. Unmanned aerial vehicles (UAVs) are remotely piloted or self-piloted aircraft that can carry cameras, sensors, communication equipment, or other payloads.[3] This purpose of this paper is to discuss UCAV systems however it is important to understand that these systems may have similarities to UAVs and these points will be brought out between the two systems when appropriate. There is an assumption the reader has a fundamental working knowledge of the DOD, USAF, and a basic understanding of combat flight operations.

Notes

[1] Lt Gen Jay W. Kelley, *2025 Executive Summary,* 1996, Maxwell AFB, AL.: Air University Press, 5

[2] Robert Schwanhauser, "Unmanned Aerial Vehicle: From WW I Through Today", *Aviation Week and Space Technology International Guide to Unmanned Vehicles/1997-98: 10*

[3] Department of Defense. Congressional Budget Office. *Options for Enhancing the DOD Unmanned Aerial Vehicle Programs.* September 1998 http://www.cbo.gov/showdoc.cfm.index

Chapter 2

Air Force 2025

> *Efforts like **2025** have forced us to face our changing environment in a systematic and broad-based way, with the major commands and the headquarters working to find a coherent, clear course. Our intent is not just to paint a picture of the future—interesting though such a picture might be—but to lay out the paths toward the most promising capabilities, and to then build this long-range planning focus into the staff on a permanent basis.*
>
> —Dr Sheila E. Widnall

The former Chief of Staff of the USAF, General Ronald R. Fogleman, tasked Air University at Maxwell AFB, AL to look 30 years into the future to identify the concepts, capabilities and technologies the United States will require to remain the dominant air and space force in the 21st century.

The Air University (AU) commander led a team of 200 students and faculty from the Air University's Air War College, Air Command and Staff College, 15 scientists and technologists from the Air Force Institute of Technology (AFIT), Air Force Academy and Air Force Reserve Officer Training Corps (ROTC) from around the country. Numerous retired general officers contributed their opinions and insights as well as over 2,000 contributors from around the world who participated through web pages and Internet dialogue.[1] Also selected were academic and business leaders from civilian communities across the nation during the 10-month effort in order to meet General Folgleman's

tasking.[2] It was the team's responsibility to develop and execute a plan that would compile information leading to the publication of 2025.

The methodology of the 2025 study was searching multiple sources of data and concepts, creating a system to harvest ideas, connect diverse players, integrate cross talk on virtual and actual communication nets and finally encouraged maverick thinking in an environment made up of both operators and scientist.[3] The body of the report detailed 41 white paper summaries totaling nearly 3,300 pages.[4]

Search for the 2025 value model

Once the methodology had been established it was time to collect a wide range of data to be analyzed as to what systems offered the greatest potential to support future air and space operations.[5] The AU white papers compiled, identified 43 unique high leverage systems as potential defense systems to be implemented in 2025.[6] A value model was needed to identify which of these potential systems would become the most critical high leverage systems responsible in defending our nation in 2025. The complexity of this issue was to either develop a new model or use a model that had already been used before in the DOD. Because the current models did not meet the requirement of 2025 a new model "Foundations 2025" was developed and implemented.[7]

Weighting and Scoring

After all the potential systems were identified, each one was ranked and weighted based on its functions, tasks and qualities. Another aspect of the 2025 plan was the development of alternate futures that would assimilate the world's strategic environment in the year 2025. The identification process and explanation of these alternate futures

will not be discussed in this paper but may be found in the 2025 plan. The Air University team understood that these alternate futures would require different systems for defense. For example, one particular high leverage system that would be applicable as a defense system in one alternative future may not be adequate in another. Another area the team looked at was what type of technology already existed or what type of technology required further development. Each of the 43 systems were weighted based on its dependency on technology. Systems requiring little technological dependence were weighted higher.[8] Each leverage system's weights were plotted on a scale based on its value and technology challenge.[9]

Identified High Leverage Systems

The AU team analyzed the data on the scale and identified the 10 highest leverage systems as those systems with the highest value for their contribution to achieving air and space dominance in 2025. The following is a list of these top 10 high leverage systems:[10]

1. Global Information Management System (GIMS)
2. Sanctuary Base
3. Global Surveillance, Reconnaissance, and Targeting System (GSRT)
4. Global Area Strike System (GLASS)
5. Uninhabited Combat Air Vehicle (UCAV)
6. Space-Based High Energy Laser System
7. Solar-Powered High Energy Laser System
8. Uninhabited Reconnaissance Aerial Vehicle (URAV)
9. Attack Microbots
10. Piloted Single Stage to Orbit Transatmospheric Vehicle

Importance of Uninhabited Air Vehicles

It is very easy to see how much importance the AU team valued UCAV potential based on its fifth position among the top 10 systems identified. It's not to say the other

systems are not as important but it's the UCAV's similarities to the UAV system that made it an interesting topic to research. The UAV is part of the leading technology explosion in the Air Force. This type of capability will have significant impacts on the future of our service as well as our sister services and even the way the Air Force will operate with its allies. Some of these impacts concern the defense of our country as well as reducing our military personnel risk into harms way during conflicts. Also important is the integration of this emerging technology with our coalition forces and how to integrate the use of these systems into to our airpower doctrine. It is important to emphasize that 2025 was charged with looking into the future and not necessarily focusing on existing capabilities. However, 2025 does discuss that certain systems were rated high based on their capability with the expanding technology development of today. Therefore similarities can be seen with the UCAV of the future and our current day UAV systems.

The defense of our country is very important as well as the public's concern in the prevention of loss of life. The use of UCAVs will certainly aid in the prevention of friendly loss of lives. It is for this reason there will be strong backing within the US Government, DOD and more importantly our country's general public in the UCAV program. A similar DOD program of unmanned aerial vehicles started out slow but has been rejuvenated over the years solely based on the increasing involvement of US forces in worldwide skirmishes. As the Services continue to downsize, the emphasis on survival for the remaining personnel will be critical. The affect of today's media on the general public plays an important part of the military's decision process. It is possible that through the use of UCAVs, the survival rate of our military forces will be significantly

increased. It is necessary to briefly provide background information on some UAV systems and show how they were successful in improving survival as well as their part in laying down a roadmap for the potential UCAV program.

Notes

[1] Lt Gen Jay W. Kelley, *2025 Executive Summary,* 1996, Maxwell AFB, AL.: Air University Press, 6

[2] *Quicklook at 2025*, on-line, Internet, June 1996, available from http://www.au.af.mil/au/2025

[3] Kelley, 6

[4] Ibid., 6

[5] Jack A. Jackson, *An Operational Analysis*, 1996 Maxwell AFB, AL Air University Press, 5

[6] Ibid., 17

[7] Ibid., 12

[8] Ibid., 22

[9] Ibid., 24

[10] Kelley, 36

Chapter 3

Uninhabited Air Vehicle Background

Technologically superior equipment has been critical to the success of our forces in combat.

- Joint Vision 2010

US interest in the development of UAVs has been a roller coaster ride filled with peaks and valleys when compared to our aircraft involvement in the world's strategic environment. The strategic environment is defined as the collection of global conditions and forces that influence how we pursue our national security.[1] History shows that it usually takes an international incident threatening our national security to highlight a military deficiency and stir a desire for new, innovative methods to support national objectives.[2]

Historical Development

The first military interest in aerial activity dates back to the late 19th and early 20th century when military personnel were attached to kites as observers. As years went on the interest grew in forms of balloons, airships and then the airplane.[3] The first heavier than air, powered, sustained, powered flight was achieved by a pilotless aircraft named "Aerodrome No. 5 built by Dr Samuel Pierpoint Langley.[4] He launched his steam-

powered craft over the Potomac River on 6 May 1896 for a flight lasting over one minute.[5] It is safe to say that unmanned airplane race has begun.

WW I saw the use of UAVs solely due to the breakthrough in technology. The US Navy carried out limited tests with the first radio-controlled aerial torpedoes in December 1917. The converted Curtis N-9 trainer was powered by a 40 horsepower (hp) engine and capable of flying 50 miles carrying a 300 pound (lb) bomb.[6] Charles Kettering of Delco Company, later General Motors, designed a more sophisticated unmanned aircraft. Built primarily out of wood and canvas, the "Kettering Bug" cost some $ 400 dollars each and was the first UAV to be massed produced.[7] Launched from a wheel trolley, the "Bug" could be pre-programmed to drop on targets by means of a engine driven cam which would unscrew the wing retaining bolts over a set distance. Although the initial tests were somewhat erratic, the "Bug" was ordered in large quantities in the last few months of the war but was canceled after the armistice.[8]

Aviation experienced more rapid advances in technology between the wars. The invention of the automatic gyroscopic stabilizer (which helps keep an aircraft flying straight and level) by Dr Peter Cooper and Elmer Sperry was surpassed by improved radio technology which greatly improved an aircraft's flights controls and maneuvering capability.[9] Radio control technology gave rise to the Army's drone program.

The Chief of the Air Corps, General Oscar Westover wanted a 20-30 mile weapon with a 200-300 pound warhead at a cost of $300 to $800 dollars per copy.[10] Charles Kettering reenters the picture with his General Motors A-1. A 200-hp monoplane carrying a 500-lb bomb to a range of 400 miles with both automatic and radio flight controls.[11] The vast distance to the targets degraded the accuracy of the gyros as the

flight progressed. After several modifications to the catapult system, an air launch option was proposed from a North American B-25. The flight control problem was still unsatisfactory and the project was canceled for non-performance in 1943.[12]

The Fieseler Fi-103, better known as the V-1 was ordered at Hitler's command specifically for use against non-military targets. The Luftwaffe successfully operated the "Vergeltungswaffe (revenge weapon)-1" with the first ground launches in December 1943 from sites in the Pas de Calais toward the United Kingdom.[13] Great Britain's Royal Air Force retaliated with over 16,000 tons of bombs dropped on the V-1 sites. Germany again escalated hostilities by air launching the flying bombs from the wings of Heinkels (He 111s).

To combat the V-1 threat, drone versions of US bombers were developed in July 1944 as part of the USAAF/Navy "Project Anvil".[14] The US Navy used PB4Y-1 Liberators equipped with remote controls, a TV-guidance system, and loaded with 25,000 lbs of torpex high explosive. Guided by a PV-1 Ventura "mother" ship aircraft, the PB4Y-1 would take off with a two-man crew who would climb to 2,000 ft and set a course for the V-1 sites in France before bailing out. The first operational Anvil flight in 1944 was a tragic failure. Flown by a volunteer crew of Lt Bud Willy and Lt Joseph Kennedy Jr, brother of the future US President, John F. Kennedy, a PB4Y-1 number 32271 exploded soon after takeoff killing both on board before they could successfully bail out of the aircraft.[15] Despite this failure the PB4Y-1 was successful against targets later on. Meanwhile, the B-17s were converted in a similar way as part of Project "Aphrodite". With 20,000 lbs of explosives on board, a pilot and technician would take off the aircraft, activate the fusing mechanisms of the weapons, and then bail out of the

aircraft over England.[16] The USAAF was concerned with additional lives lost with these new aircraft so some off these bombers had open cockpits to enable the crew to bail out more easily.[17] Looking ahead at today's interest in UCAVs there would be pilot in the aircraft to begin with so this would eliminate any concern for crews bailing out. Technology has not quite allowed for this type of operation to occur yet so the man in the cockpit must continue. None of the Aphrodite aircraft hit their precise targets and were never seen as more than an area weapon. Aphrodite was yet another unmanned aircraft program with technological problems that was being developed as American convention bombing effectiveness was improving. So with the program no longer in the limelight it quickly lost interest.

In 1949, the USAF awarded to Ryan Aeronautical Company for their XQ-2 with the Frederick Flader J-55 turbojet engine. The XQ-2 was then changed the "Firebee". The "Firebee" has represented one of the most enduring and widely used unmanned aircraft. Over the years other types of unmanned aircraft have been cheaper and some have been produced in greater numbers, but none has equaled the versatility and adaptability of the basic "Firebee" design.[18]

Still the most important attribute of unmanned aircraft is not that they are cheaper and more clever than manned aircraft, but using them saves crewmembers lives. This was proven very well during combat operations during the Vietnam War.[19] Ryan Aeronautical (later to become Teledyne Ryan Aeronautical) made a proposal to the USAF to use modified unpiloted drones for reconnaissance missions. The study involved reducing the radar signature of a modified Q-2C "Firebee" drone by placing a specially designed screen over the intake and putting radar absorbing blankets on the fuselage and

then covering the entire aircraft with a new anti-radar paint.[20] The use of these "Firebees" for reconnaissance were given the code-name "Fire Fly" which was later changed to "Lightning Bug".[21] The big benefit was now these Lightning Bugs would have a lesser chance of being detected in heavily defended areas. This was an alternative measure instead of risking pilots. These drones were able to create a lot of supporters in the reconnaissance community. A big concern during combat mission especially reconnaissance was the possibility of being shot down and captured as a prisoner of war. This still holds true today. The general public does not want to see their captured serviceman paraded on television and used as negotiating pawns. The unmanned aircraft will be highly supported if it will reduce the risks of our crewmembers.

Meanwhile, a highly significant incident took place that help rejuvenate the interest in unmanned aircraft. On May 1, 1960 Francis Gary Powers was shot down in his U-2 reconnaissance aircraft 1200 miles inside the Russian border[22]. Powers was captured as well as his aircraft wreckage and put on display for the world to see.[23] This shoot down was directly responsible for the development of the fastest and highest-flying unmanned aircraft ever to reach operation. So with the cold war at its height, no money or effort was spared in obtaining high quality images of important targets. Lockheed's "Skunk Works" under the leadership of legendary Clarence "Kelly" Johnson was given the job of developing a high-speed reconnaissance drone.[24] Having built and tested the 2,000 mph A-12 aircraft for the CIA and SR-71 "Blackbird" for the USAF, Johnson and his team decided the only way to successfully employ such a strategic long range system was for an air launch from the top of an A-12. It was later changed to the M-12 because it was so designated as the mother ship. The first three test missions were successful with disaster

occurring on the forth. On release at over 2,000 mph the D-21 pitched up violently and struck the mother ship. The two man crew ejected safely but one later drowned awaiting rescue.[25] Johnson and his Skunk Works team worked with the USAF on another air launch program from the wing of a modified B-52 aircraft. The four operational missions flown were plagued with miscues but still deemed a successful program. The project was officially canceled in July 1971.[26] The D-21 never flew again, although there were reports that National Aeronautical and Space Administration (NASA) was planning to use it for high speed research. Some sources suggested that this was part of a front for the mysterious high-speed project code-name "Aurora".[27]

The concern of putting our crewmembers needlessly into harms way rose again after the downing of another high valuable U-2 aircraft. This time the pilot was not as fortunate as Gary powers. The U-2 aircraft was shot down while flying over Cuba during the opening rounds of the Cuban missile crisis.[28] Shortly after this incident, then Attorney General Bobby Kennedy received a reconnaissance drone capabilities brief and upon learning that only two systems were available in the entire Air Force, Kennedy demanded more.[29] One phone call to Ryan Aeronautical and the Model 147-B big wing drone with Doppler navigation system was under way.[30] The emphasis is to reduce the loss of life risk for our pilots. Could this mission been done with an aircraft without a pilot?

General awareness and military interest into UAVs did not surface again until the Israeli Air Force employed them during the October 1973 Yom Kippur War and in 1982 against Syrian missile batteries deployed in Lebanon's Beka's valley.[31] It was reported that the Israelis used "Firebees" armed with Shrike anti-radar missiles to lead attacks

against Egyptian air defenses and that one "Firebee" was targeted by 32 surface to air missiles before it returned safely to its base.[32] During 1982 the Israeli Air Force again used UAVs to fly over the Syrian deployed missile sites to gather important electronic data. Although one "Firebee" once shot down, valuable electronic information was still collected and further more there was much emphasis on the fact that there was no lose of life.[33] After mounting tensions, Israel launched an attack called Operation "Peace for Galilee" to drive the Syrian supported Palestine Liberation Organization from Lebanon. The UAV's work was deemed immeasurable and led to the successful attacks against the missile sites. Overall, the Israelis were able to destroy 17 of the 19 sites detected by their UAVs and this allowed the Israeli fighters to shoot down 85 Syrian fighters.[34] Several UAVs were lost but all were attributed to mechanical failure.[35] A keynote to think about is what price would the Israelis paid if the UAVs had not provided such critical information. The UAVs saved lives and also prevented loss of life by being unmanned.

The Israeli success inspired then Secretary of the Navy John Lehman to push for his service to acquire UAVs, primarily to support targeting and to conduct battle-damage assessment for US battleships. His efforts led to the Navy and Marine Corp acquiring the "Pioneer" UAV system, which is still in use today.[36] This system has been employed in many US operations since the 1980's, including the Gulf war and more recently operations in Bosnia.

In recent years, the Pentagon has started a number of other UAV development programs. Two of them named "Medium Range" and "Hunter" were ultimately canceled. Another UAV, called "Predator", has been acquired by the USAF and is conducting operations missions.[37] Three newer systems, "Darkstar", "Global Hawk", and "Outrider"

are currently under research and development and some have entered flight testing.[38] DOD officials appear more optimistic about these groups of UAVs than the earlier ones, partly because advances in technologies such as miniaturization, make developing UAVs easier and also partly because developers now have more experience in integrating all the components that compose a UAV system (such as the air vehicle, ground support equipment, sensors, communication equipment and other payloads).[39] Technology is still evolving and we have come a long way when pilots were jumping out of B-24s and B-17s during WW II and calling them unmanned. The USAF is not only concerned on accomplishing the mission but also has high regards in reducing loss of life.

UAV Missions and Functions

Unmanned aerial vehicles have the unique capability to gather important intelligence data. For example, a brigade commander whose responsible for seizing the ground in his area of operations will want to know the size, quality, and disposition of any enemy forces in that area. A UAV is designed to support such a commander with nearly instantaneous video, day or night operations without risking pilots or forward observers. A reconnaissance mission would have the UAV obtain vital information about enemy activities and resources or collect data about meteorological, hydrographic, and geographic characteristics of an area. Surveillance can be conducted with the newly developed high endurance UAVs. It can watch buildings and observe the arrival or departure of mobile missile systems from a designated area. A wide area aircraft such as the Joint Surveillance Target Attack Radar System might identify a group of moving vehicles. A UAV may be called in to verify the vehicles type or location. Target

acquisition or target designating is also an important task. A UAV equipped with a laser designating system could lase a target so another aircraft could attack it with a precision guided munitions.

A UAV can also be used as a communication relay. In battle, forces may move quickly and exceed the range of their communication system, as happened in Desert Storm.[40] A UAV can bridge the gap between the leading edge of friendly troops and higher echelons of command located in the rear of operations. One more critical mission in war fighting is the ability to conduct battle-damage assessment on targets. The UAV can substitute a human forward observer to give gunnery crews timely feedback. The UAV can also perform this same type of mission whether the targets are attacked by aircraft or missiles. The UAV is an essential asset while conducting operations on the battlefield. The use of UAVs will continue and the demands for their capability will also increase. As long as there is a need for intelligence, there will be a need for UAVs. Will there be a requirement for similar type platforms? This paper will explore that possibility.

Notes

[1] Strategic Environment Course, Air Command and Staff College, Air University, Maxwell AFB, AL, *Strategic Environment*, PowerPoint presentation, slide #2, 13 Oct 98

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[3] Microsoft, *Microsoft Encarta 1996 Encyclopedia*, Aviation, CD-ROM

[4] Hugh McDaid and David Oliver, *Smart Weapons,* Orion Publishing Group, Barnes and Noble Books 1997, 10

[5] Ibid.

[6] Ibid.

[7] Ibid., 11

[8] Ibid.

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[9] Thomas Ehrhard, *The US Air Force and the Unmanned Aerial Vehicles*, John Hopkins University paper, 1998, 6

[10] Kenneth P. Werrell, *The Evolution of the Cruise Missile*, Air University Press, Maxwell AFB, AL 1985, 21

[11] Ibid., 26

[12] Ibid., 30

[13] McDaid and Oliver, 17

[14] Ibid., 21

[15] Ibid.

[16] Werrell, 32

[17] McDaid and Oliver, 21

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[19] Ibid., 32

[20] Ibid., 33

[21] Ibid.

[22] Schwanhauser, 12

[23] Ibid.

[24] Ibid., 30

[25] Ibid., 31

[26] Ibid., 32

[27] Ibid., 33

[28] Schwanhauser, 12

[29] Ibid., 14

[30] Ibid.

[31] McDaid and Oliver, 50

[32] Ibid., 51

[33] Ibid.

[34] Ibid., 53

[35] Ibid.

[36] Department of Defense, Congressional Budget Office (CBO), *Options for Enhancing the Department of Defense's Unmanned Aerial Vehicle Programs*, on-line, Internet, September 1998, available from http//:www.cbo.gov/showdoc.cfm?index, Sect 3

[37] Ibid.

[38] Ibid.

[39] Ibid.

[40] Ibid., sect 3

Chapter 4

Future Requirements

We have taken the charge as an obligation to find and create new ideas. We believe those ideas will make the Air Force of the future effective, affordable, and capable in seamless joint and multinational operations in which it achieves its purpose to fight and to win the Nation's wars.[1]

Ronald R. Fogleman, General, USAF
Chief of Staff

In the future there will be a mix of inhabited and uninhabited aircraft. The uninhabited aircraft of the present have particular advantages such as costs and their endurance. These systems could be either cruise missiles or reconnaissance vehicles as mentioned in the previous chapter.[2] The uninhabited combat aircraft is a newer high performance aircraft that is more effective for particular functions than the inhabited counterparts.[3] These new aircraft will be more maneuverable and carry more ordnance. This is a key asset in counterair and counterland operations.

Budget

Over the last few years the DOD has invested an estimated 105.2 (FY97), 138.3 (FY98), 115.0 (FY99) million dollars in UAV programs.[4] This significant amount of money demonstrates how much interest the DOD has in assisting the Services pursue information superiority in the 21st century.[5] The allocation of money to procure a

particular system is a strong statement of commitment not only to the military community but also to our general public.

Uninhabited Combat Air Vehicles

Time has quickly past since the publishing of 2025. And since the release of the AU white papers there has been some indications of progress made in the direction of UCAVs. The Naval Air Systems Command announced in October 1997 a contract was awarded to Lockheed Martin to define a family of uninhabited naval strike aircraft that could provide the ability to be launched from a variety of naval ships as well as ballistic-missile submarines.[6] The uninhabited naval strike aircraft will be based on missions for attacking high-value fixed targets or for suppressing enemy air defenses (SEAD) within a range of 600 miles.[7] One of the concepts the Navy is working on with a UCAV is its autonomous capability of detecting moving targets. The researchers at the Naval Research Laboratory (NRL) successfully demonstrated autonomous detection of both airborne and ground moving targets.[8] The work, performed under the NRL's "Dark Horse" program, demonstrated the potential capabilities needed for autonomous UAVs.[9] The NRL "Dark Horse" program funded by NRL / Office of Naval Research is a four year effort to develop and demonstrate enabling technology for future manned, reconnaissance, and UCAV systems.[10]

While the Navy has been currently investigating systems to be integrated on UCAVs, Lockheed Martin Tactical Aircraft Systems (LMTAS) and Tracor Flight Systems, Inc. announced they will both support each other in developing UCAVs and "Next Generation Aerial Targets (NGAT) based on the F-16.[11] Tracor Flight systems is the US leader in

full-scale and sub-scale aerial target development, production, flight testing, and certification.[12] The company has participated in virtually every major full-scale target programmed has been involved in every facet of conversion and systems engineering, automatic flight control systems development, and full-scale engineering development. [13] The arrangement with Tracor allows for mutual development of a total system that would support the NGAT and UCAV programs. USAF inventory F-16s are being considered to support the collaboration. [14] Since the start of this research project there had been no association with a UCAV as a particular airframe. Under this approach, LMTAS's research and development of low cost flight control concepts could result in flight control enhancements that will host many of the functions needed to convert a manned fighter into a fully integrated UCAV.[15]

There are plans in the US aerospace community regarding the development of a UCAVs.[16] These plans range from mundane, converted F-16s for the Air Force and F-18s for the Navy to hypersonic weapons delivery systems.[17] There are two schools of thought about how to design the UCAV: one is essentially evolutionary - design a manned fighter but leave out the cockpit and the other is revolutionary - design it more like a reusable missile.[18] There has been one other aircraft design that was discovered during the research process as having UCAV potential - the General Dynamics (now Lockheed-Martin) / McDonnell Douglas A-12 Avenger II.[19] This was a subsonic highly stealthy strike aircraft aimed at replacing both the US Navy A-6 Intruder and the USAF F-111s.[20] Although the A-12 was canceled in 1991 because of cost over-runs and reduction of tension caused by the end of the cold war, at least $2 billion and even as much as $4 billion dollars was spent on the A-12 program.[21] The authors of the book

Smart Weapons believe this abandoned platform has been resurrected and is secretly undergoing testing as a UCAV to conduct SEAD operations.[22]

Organizations

There have been many commercial industries and organizations that have expanded their horizons since the interest of UAVs has increased. Our own Air Force has been working diligently over the last few years within its UAV programs setting up new organizations. The USAF Material Command has set up a UAV branch within their Air System Center located at Wright-Patterson AFB, OH.[23] Headquarters Air Combat Command re-engineered their requirement directorate with the addition of the special management office for UAVs in their reconnaissance and surveillance division.[24] The year of 1997 was very busy standing up its second Predator UAV unit. The 11th Reconnaissance squadron was stood up in August 1997 at the Air Force's Indian Springs Auxiliary Field, NV (near Nellis AFB).[25] Another giant stepping-stone for the USAF was the establishment of a UAV Battlelab, which officially stood up at Eglin AFB, FL in July 1997.[26] The USAF will probable continue to establish more UAV organizations much like it has in the past with its manned aircraft units. There is one issue the USAF will have to continue pressing with in order to make the UAV program as successful as its other established aerospace organizations. The USAF must continue to integrate the UAV capabilities with the rest of the service or the rest of the USAF will be left in the dark.

Since the UCAV concept is still emerging there has not been any requirement to officially establish any squadrons as UCAV units. The USAF has been working with the

Defense Advanced Research Projects Agency (DARPA). DARPA is the central research and development organization for the DOD.[27] It manages and directs selected basic and applied research and development projects and pursues research and technology where risk and payoff are both high.[28] Within the DARPA organization there is a branch dedicated to the UCAV program. The objective of the DARPA/Air Force UCAV Advanced Technology Demonstration program is to demonstrate the technical feasibility for a UCAV system to effectively prosecute 21st century lethal strike missions.[29]

In March of 1998, the DARPA/ USAF UCAV program team published the MDA972-98-R-003 solicitation to the commercial industry to participate in the UCAV Advanced Technology Demonstration (ATD).[30] The ATDs are the military departments and defense agencies narrowly focused technology demonstration to identify key technologies ready for transition and demonstrate their performance parameters.[31] The solicitation's vision describes the UCAV as an affordable weapon system that expands tactical mission options for revolutionary new air power.[32] There is a great deal text in the solicitation that explains why the USAF and DOD are pursuing the ideas of UCAVs. Most of the motivational verbiage extends from the requirements stressed in *Joint Vision 2010* and information contained *New World Vistas Air and Space Power for the 21st Century* report.[33]

Headquarters Air Combat Command, Directorate of Requirements divided the spectrum of potential UCAV missions into three categories: special application, force enabler, and alternative strike aircraft.[34]

The following is a brief description of each of these categories:[35]

1. Special application: UCAVs perform punitive strike missions where we are unwilling to risk a pilot.

2. Force enabler: UCAVs conduct SEAD and deep strike missions in support of manned strike packages.

3. Alternative strike aircraft: UCAVs perform a wide variety of missions competitive with the Joint Strike Fighter.

The breakdown of these potential UCAV missions has set the stage for the commercial industry to start fielding a platform that will meet these requirements. The remaining portions of the solicitation pertain to the contractual issues that must be agreed upon at the time the company submits their response. In appendix A of the solicitation contains the System Capability Document (SCD). This document describes the design and capabilities for a notional UCAV operation system, which effectively and affordably prosecutes SEAD/strike missions as part of an integrated air campaign in the post 2010 timeframe.[36]

In April 1998, the DARPA/ USAF UCAV program team selected four contractor teams for the first phase of the UCAV Advanced Technology Demonstration.[37] The selected contractor team leads are:[38]

1. Lockheed Martin Tactical Aircraft Systems, Fort Worth, TX

2. Northrop Grumman Corporation, Military Aircraft Systems Division, Pico Rivera, CA

3. Raytheon Company, Raytheon Systems Company, Falls Church, VA

4. The Boeing Company, Information, Space & Defense Systems, Phantom Works, Seattle, WA

Each team has agreed to receive $4 million dollars for the initial 10-month trade study, analyses, and preliminary design phase.[39] At the conclusion of the 10-month period the DOD will decide whether to proceed with the 42-month second phase valued at approximately $110 million dollars.[40] The selected team for the second phase will need to complete the development, fabrication and flight testing of two demonstrator air vehicles and a reconfigurable mission control station.[41]

The Air Force Research Laboratory (AFRL) has been in existence for a very long time. Within the AFRL is the Integration and Operations Division, which falls under the Air Vehicles Directorate.[42] The mission of the Integration and Operations Division is to integrate multi-discipline functional areas, such as aeromechanics, structures, flight control, crew systems, propulsion, avionics, and weapons to maximize the payoff of the technologies on overall system performance and affordability.[43] Since the UCAV is part of new emerging technologies, the AFRL established the UCAV office within the Integration and Operations Division. The UCAV office provides support to the DARPA/AF UCAV Advanced Technology Demonstration Program office by focusing laboratory science and technology investments and providing technical expertise to the UCAV program manager.[44] Expertise includes participation in contractor technical reviews, evaluation of contractor proposals, membership on contractor/governmental technical teams, and conducting independent trade and analysis studies.[45]

It has been almost 10 months since the award of the UCAV phase I contract and the AFRL UCAV program office has been probable working very closely with the

DARPA/AF UCAV office as they prepare to award a single contract to participate in the phase II of the program. It is imperative as new systems emerge and the number of organizations spring up the lines of communication are kept open. The information super highway is one good way to ensure all established and potential parties obtain the latest information on important topics. The best way to exchange information is still through a good eye-to-eye meeting and a handshake. A good example of this is through the use of integrated process teams. Headquarters USAF held a UAV Futures Integrated Process Team (IPT) meeting in December 1998. One of the significant aspects of this meeting was the integration of the UCAV IPT that HQ ACC formed. The ACC IPT discussed the future missions of UCAVs and also the status of the UCAV ATD contract.[46] This is basically the same information that was discussed earlier in this paper. Another topic discussed by the UAV IPT chairman was dissolving the UAV IPT and incorporating its functions under one office in the Air Staff.[47] Although the UCAV IPT has not reached this stage, it is important that there is a team established and they will continue to integrate all the UCAV organizations to keep the stream of information flowing. One last item from this meeting was a representative from the Attaché Defense Equipment Air, British embassy briefed how the United Kingdom's UAV program office is pursing a UCAV to replace their aging Tornado GR-4 aircraft.[48] The British have identified many of the same issues as the US has with UCAVs and hope to field a Future Offensive Air System (FOAS) by 2018.[49] The FOAS studies have identified a range of potential UAV and UCAV missions such as reconnaissance, SEAD, communications relay, and target designation.[50] These are all very similar missions the USAF has discussed for their

UCAVs. If the US wants to survive the future it needs to stay on top of the technology emerging today. If it does not, the consequences may be too high.

Others in the Race

As mentioned earlier the United Kingdom is already looking into some type of UCAV to include into their inventory. The Royal Air Force (RAF) is interested in such a UCAV system for their aging Tornado aircraft. The RAF's acquisition of UCAVs along with the US will greatly enhance the coalition firepower in the battlespace. France is also very much interested in pursuing a UCAV program. In fact the French Ministry of Defense (MOD) and the USAF have invited tenders for participation in a four year plan to develop concept of operation and core flight control and flight management technologies for UCAVs.[51] This is part of the UCAV solicitation that was addressed earlier in the paper. The French are responsible for package configuration, task allocation, formation management, and communication management.[52] A special consideration needs to be taken under advisement when working with the French. They are known to quickly sell a weapon system to unfavorable country for a profit. Recent history shows France's participation with Iraq in selling Mirage aircraft and missiles along with critical electronic components used to makeup Iraq's intricate air defense systems. After all, the Iraqi high tech "Kari" system is the French spelling of Iraqi backwards.

Another country that has shown an interest in UCAVs is Germany. They too like the RAF have an inventory of Tornado aircraft that are aging and will soon need to be replaced in the future. With three major European countries stating desires to pursue

UCAVs, there is thus scope for a major European or trans-Atlantic joint program.[53] There was not much information available on the status of Israel's position on UCAVs. The country already has a success story with UAVs and they continue to explore futuristic developments in UAV programs. One such program is their Boost Phased Interceptor (BPI) UAV aimed at intercepting ballistic missiles in their boost stage.[54]

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[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] McDaid and Oliver, 148

[17] Ibid.

[18] Ibid.

[19] Ibid., 153

[20] Ibid.

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[22] Ibid., 152

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[29] Defense Advanced Research Projects Agency (DARPA) Homepage, Tactical Technology Office (TTO), Unmanned Combat Air Vehicle branch, on-line, Internet, available from http://www.darpa.mil/tto/ucav.html

[30] IBID., Solicitation Homepage

[31] Department of Defense Science and Technology Strategy, *Moving Technology Rapidly into use - ATDs and ACTDs*, on-line, Internet, 1996, available from http://www.dtic.mil/dstp/96_docs/strategy/strat4.html

[32] Ibid.

[33] Ibid., 4

[34] Ibid.

[35] Ibid., 5

[36] Ibid., Appendix A

[37] Defenselink News, *DARPA and AIR FORCE Select UCAV Contractors*, Immediate Release No 178-98, on-line, Internet, 16 April 1998, available from http://www.defenselink.mil/news/apr1998/b04161998_bt178-98.html

[38] Ibid.

[39] Ibid.

[40] Ibid.

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[46] Lt Col B. F. Lindner, Chairman UAV Futures Integrated Process Team letter, subject: *Minutes, UAV Futures Integrated Process Team Meeting*, 2 Dec 98

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[48] Ibid.

[49] Ibid.

[50] Ibid.

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Chapter 5

Summary and Conclusion

> *As we approach the beginning of the 21st century, the United States remains the world's most powerful force for peace, prosperity and the universal values of democracy and freedom. Our nation's challenge and our responsibility is to sustain that role by harnessing the forces of global integration for the benefit of our own people and the people around the world.*
>
> *A National Security Strategy For A New Century*
>
> *October 1998*

The purpose of the research paper was to investigate the USAF's progress in pursuing the use UCAVs as a high leverage system in the defense of our nation in 2025. The first chapter gave a brief description of the subject and some limitations, definitions, and assumptions presented in this paper. Chapter two analyzed the Air Force 2025 results, identified the high leverage systems, and the importance of uninhabited air vehicles. Chapter three addressed the historical development of UAVs, their missions, functions. The chapter also tried to tie in similarities between UAVs and UCAVs and how UCAVs may follow the same roadmap as did the UAVs. Chapter four discussed the majority of the USAF's progress in the field of UCAVs and what other countries may be pursuing the quest for emerging UCAV technologies.

Future Consequences

The importance of aerospace technological dominance has never been more evident than during the Gulf war. The vital role that technology played in the preservation of freedom and the safety of our troops was obvious to all.[1] Military planners believe the push for UCAVs will intensify because enemy air defenses worldwide are being updated with a mix of modern technologies that make them hard to keep track of and counter.[2] The increase in enemy capabilities makes the decision to pursue a UCAV program very easy. With newer capabilities, our enemy has the ability to use these technologies against our neighbors, our interests and our crewmembers. It's the consequences we will have to pay for if we are unprepared. The USAF must continue to lean forward in the driver's seat of technology. It is the only way to protect ourselves.

Principle Conclusion

The Air Force has made very positive steps in pursuing UCAVs since the publishing of 2025. Although most of the evidence is not obviously visible in terms of hardware, the fact the USAF has identified contractors to develop a UCAV ATD should send out a strong signal about their commitment. It won't be long before the public will be reading in the papers or on the Internet about the single contractor awarded the task of developing further UCAV technologies and concepts of operations. Like most other programs the USAF has developed, it takes time for these concepts to mature and to be fully understood. The USAF is slowly establishing the right organizations to assist in keeping the UCAV dream on the right track. If the lessons learned over the years from the UAV program are incorporated into the UCAV program there is no doubt the UCAV dream

will become reality. The use of UCAVs will greatly reduce the number of casualties of war. In particular, it will reduce the number of prisoners of war. UCAVs will also reduce unnecessary enemy casualties by limiting collateral damage.

The UCAV will emerge into one of the USAF's greatest programs as did the stealth fighter and bomber. The UCAV program will get full backing within the USAF, DOD and the American people because it significantly reduces the loss of lives to our airman.

Finally, the relationship of the Air Force to technology is a living one. The USAF is highly depended on today's technology. The USAF is always planning for future threats and an enemy's technological capability. There is also a need to plan how an enemy might exploit our technology. This will drive our country to even a deeper need for more sophisticated technology. It will be the dedicated people in our Air Force to apply today's science and technology principles to prepare us for the future..[3] UCAVs are vital to the defense of our nation in 2025.

Notes

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Glossary

ACC	Air Combat Command
ACSC	Air Command and Staff College
AFB	Air Force Base
AFRL	Air Force Research Laboratory
ATD	Advanced Technology Demonstration
AU	Air University
BPI	Boost Phased Interceptor
CBO	Congressional Budget Office
CIA	Central Intelligence Agency
CSAF	Chief of Staff of the Air Force
DARPA	Defense Advanced Research Project Agency
DOD	Department of Defense
FOAS	Future Offensive Air Systems
FY	Fiscal Year
GIMS	Global Information Management System
GLASS	Global Area Strike System
GSRT	Global Surveillance, Reconnaissance, and Targeting System
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transport Protocol
IPT	Integrated Process Team
JV	Joint Vision
LMTAS	Lockheed Martin Tactical Aircraft Systems
MOD	Military of Defense
NASA	National Aeronautics and Space Administration
NGAT	Next Generation Aerial Target

NRL	Naval Research Laboratory
PLO	Palestine Liberation Organization
RAF	Royal Air Force
SCD	System Capability Document
SEAD	Suppression of Enemy Air Defense
TTO	Tactical Technology Office
UAV	Unmanned Aerial Vehicle, Uninhabited Air Vehicle
UCAV	Uninhabited Combat Air Vehicle
URAV	Uninhabited Reconnaissance Vehicle
US	United States
USAF	United States Air Force
USAAF	United States Army Air Force
WW	World War
WWW	World Wide Web

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