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Looking Beyond the J-UCAS Technological Demonstrator Program's Demise

By Alain De Neve

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The J-UCAS X-45C prototype developed by Northrop Grumman (Credits: Northrop Grumman)

Abstract

In February 2006, the U.S. Department of Defense (DOD) put an end to the Join Unmanned Combat Aerial Systems (J-UCAS) technological demonstrator by declaring the program officially "terminated". Though the decision was not a real surprise in the Air Force community, reasons that led to J-UCAS program's demise are questionable and invite us to examine to what extent elements as such as technological maturity, management models, services strategies and bureaucracy might help us to explain DOD's final decision. A social deconstruction of the J-UCAS program will be helpful in order to have a better understanding of the kind of obstacles modern advanced technological military programs can suffer from.

The views expressed are only those of the author.

Keywords: UCAV, Military Technology, Social Shaping of Technology, U.S. Air Force, Capabilities, Armament.

ABOUT THE AUTHOR

Alain DE Neve is research fellow of the Center for Security and Defence Studies of the Royal High Institute for Defence. He also is PhD Candidate in political science at the Catholic University of Louvain. Issues covered by the author include: European armament programs, military technology and the social shaping of technological systems.

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ABBREVIATIONS AND ACRONYMS

AAR	Air-to-Air Refueling
C^3	Command, Control and Communication
COS	Common Operating System
DARPA	Defense Advanced Research Project Agency
DoD	Department of Defense
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
JPO	Joint Project Office
J-UCAS	Joint – Unmanned Combat Aerial System
NG-LRS	Next Generation – Long Range Strike
OSD	Office of the Secretary of Defense
QDR	Qudriennal Defense Review
SAM	Surface-to-Air Missile
SCOT	Social Construction of Technology
SEAD	Suppression of Enemy Air Defense
TBM	Theatre Ballistic Missile
TPSAs	Technologies, Processes, and System Attributes
UCAS-D	Unmanned Combat Aerial System – D
UCAV	Unmanned Combat Aerial Vehicle
USAF	United States Air Force
USN	United States Navy
UTA	Uninhabited Tactical Aircraft

1. INTRODUCTION

In the first half of 2006, and in the midst of a global review of U.S. most costly military programs – the Quadrennial Defense Review 2006 -, the Department of Defense (DoD) officially decided to put a definitive end to the technological demonstration program of an uninhabited combat aircraft also known as Joint Unmanned Combat Air Systems (J-UCAS). Officially, the J-UCAS was a joint DARPA/Air Force/ Navy effort aimed at demonstrating the technical feasibility and the military utility for a networked architecture constituted by weaponized unmanned air vehicles and sensors. The objective pursued by J-UCAS advocates was to promote the definition of uninhabited systems dedicated to a wide array of dull, duty and dangerous missions including suppression of enemy air defenses (SEAD), surveillance, precision strike and, last but not least, combat operations. Yet, this was at least the official discourse behind the technology demonstration program initiated under the auspices of the DARPA and the two services. The development of such a robotic weapon systems for expanded tactical missions has rapidly become at the center of rivalries between the Air Force and the Navy regarding the definitive panel of missions such a system would have to accomplish. Even inside each of the services cooperating on the technological demonstrator program, no single view was developed about the range of missions the future J-UCAS would have to accomplish. Besides doctrinal divergences between the U.S. services, another explanation of J-UCAS failure has to be explored. What was remarkable about the J-UCAS is that it involved not only a different way of thinking about air systems but a radical breakthrough in the way the whole process of engineering and development has to be thought.

2. DECONSTRUCTING THE J-UCAS

Now terminated as a program on its own, the J-UCAS "experiment" appears to be an ideal test-bed in order to

demonstrate how military technological programs, especially those initiated in order to explore innovative and experimental capabilities, are socially shaped. Yet, a common belief is that "*the development of technology is driven by an autonomous, non social and internal dynamic*"[1]. Such a technological determinism has been challenged by the social construction of technology (SCOT) program whose main promoters (Trevor Pinch and Wijbe Bijker[2]) have lastingly defended the idea that technological change does not necessarily mean "progress". A weaker version of such a technological determinism also exists for it supposes that, without necessarily leading towards "progress", technological innovation is following "natural trajectories".

Keeping in mind the above-mentioned considerations regarding technological innovation and progress, some interesting questions should thus be examined: what are the main incentives of technological innovation? Are disruptive technologies the result of a clear expression of needs or the derivative products of internal rivalries and interservices competitions? Finally, does technological failure sometimes lead to progress?

To resume, technological systems – especially those developed for military purposes – do not pursue a "natural, preplanned and linear trajectory". Rather, they are the result of a constant turmoil between plans, concepts and projects of diverse – and sometimes, opposing – actors. Occasionally, order emerges from such confusion and a technology succeeds. Like Janus, technological innovation is double-faced. First, technological innovation must be considered as a concrete illustration of political, military, scientific and industrial leaders' views (often contradictory) about the world military balance, be they

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[1] D. MACKENZIE, *Knowing Machines: Essays on Technical Change*, Cambridge (Mass.): The MIT Press, 1996, p. 5.

[2] W. BIJKER, T., HUGHES, T. PINCH, *The Social Construction of Technological Systems*, Cambridge (Mass.): The MIT Press, 1987.

mistaken or biased. Second, technological innovation, as it come progressively to nurture genuine operating military systems, has the potential to influence the state of world affairs. To have the "potential" does not necessarily mean that every technological advance in the field of armament will actually change or alter the balance of forces or, in a narrowest point of view, the way war will be waged in the future.

In his book *Weapons Without a Cause*, Theo Farrell argues that three questions have to be addressed to establish whether or not the military requirement for a precise weapon is genuine[3]. These questions are intended to evaluate respectively the necessity, the capability and the opportunity of an acquisition. The first question is: was the weapon intended to carry out a necessary military mission? Here, the analysis is aimed at evaluating whether or not a true security challenge does exist that justifies the development of a new technology. A second question that needs to be addressed is whether the projected weapon is "well-suited" to carry out the above-mentioned military mission? Finally, a third question will try to assess if the projected weapon is not only well-suited but also the "best-suited" for the mission. In other words, are there other, more cost-effective alternatives for meeting the security requirement defined by the policy planners? As it will be explained, neither of these questions was correctly addressed by the services involved in the development of the J-UCAS.

The J-UCAS technological demonstration program is interesting for more than one single reason. First, it is the first time that scientific and technological advances allow the U.S. military services, in coordination with the industry, to imagine the feasibility of an autonomous aerial system for defense requirements. In the same time, it must be reminded that such a technological innovation is always the result of an arbitrary process between profit-seeking (i.e. fulfill the same missions

[3] T. FARRELL, (1997), *Weapons Without A Cause: The Politics of Weapons Acquisition in the United States*, London, MacMillan Press Ltd, p. 9.

with less or more efficient means) and technical performance. In other words, like any other form of innovation, military technological innovation does not occur *ex nihilo*; it is inextricably linked to the economic context. Second, the J-UCAS served as a test-bed for a new, innovative development method in the field of military technology: the spiral model of development. Firstly implemented in information technology (IT), the Spiral Model has been extended to the military field in order to manage high-risk technological programs (i.e.: the Army's Future Combat System).

3. ORIGINS OF THE J-UCAS PROJECT

Since the inception of the J-UCAS, a great confusion seems to have existed as regards to both the origins and the objectives of the project. Neither was the purpose of the Air Force and the Navy to lead the teams in charge of the management of the program to the development of a genuine unmanned aerial and combat platform nor to deploy UCAV squadrons on a hypothetic battlefield. Rather, the primary mission the managers of the project had to fulfill was the study of the sole but ambitious technical feasibility of a wide network of various sensors in which, it is true, the aerial sensors would have to play a specific part.

3.1. Expected Advantages

Advocates of the UCAV solution regularly insist on the benefits such systems could bring to the U.S. armed forces. They affirm that UCAVs will be substantially more cost-effective than current weapons systems. Still according to UCAV's advocates, among the main advantages of the unmanned combat aerial systems figure theatre integration cost of acquisition and cost of maintenance in operation. In that sense, UCAVs will largely differ from existing military platform which are characterized by prohibitive systems of integration and maintenance. For these reasons, huge military programs are frequently shut down during budgets cuts. UCAVs are also deemed as a solution in terms of system costs. Since the *Desert Storm*

campaign, the armed forces have expressed their preference towards military options based on the use of million dollars cruise missiles and stand-off weapons. These were seen as cost-effective substitutes to expensive and huge legacy military systems.

It was also believed UCAVs could provide all of the capability of manned aircrafts with total costs below those of cruise missiles. As it will be shown further, such calculations seriously underestimated the impact of acquisition and operational costs on the global budgetary envelope.

3.2. The First Steps

At the very origins of the J-UCAS was the Uninhabited Tactical Aircraft (UTA) program. The UTA project was an effort aimed at designing low cost, small air vehicles. In a later phase, the UTA program was renamed Unmanned Combat Air Vehicle (UCAV)[4]. Since then, these acronyms have been generalized to denominate various autonomous combat aircraft project as a whole. Future orientations given to the UCAV technology demonstration program illustrated the changing tactical and strategic visions of its then main sponsor, the USAF. Originally, the UCAV program was tasked to provide the Air Force with an autonomous air vehicle dedicated to preemptive and reactive SEAD missions against fixed and mobile targets. Special focus was placed on reactive strike capabilities because of the limited ability for pilots of manned aircraft to wait for, find and eventually engage mobile targets. Industry was energetically pushing the idea of the UCAV as a solution to what it used to call the "supergap" of both the USAF and the Navy: that is the inability of existing fighters and bombers to target increasingly mobile systems such as surface-to-air missiles (SAMs) and theater ballistic missiles (TBMs).

[4] Allocution of Dr. Michael S. Francis (J-UCAS Program Office Director) at DARPA Tech 2004.

So, original requirements for a UCAV were[5]:

- a low life cycle-cost and a survivable design;
- a mission control station that can fly single or multiple UCAV in swarming squadrons;
- a secure command, control and communications network;
- completely autonomous vehicles from take-off to landing;
- off-board and on-board sensors to locate targets;
- Human involvement in targeting, weapons delivery, and target damage assessment.

The J-UCAS vision was to develop a weapon system that, according to DARPA, was to expand tactical mission options and give the U.S. Air Force with new penetrating surveillance capability. Originally, it was decided to design an uninhabited aerial platform with great operational flexibility and minimal maintenance requirements in order to reduce costs. The J-UCAS technological demonstrator was developed to operate as the nodal point of a wider battlefield network. In that sense, J-UCAS was aimed at testing the feasibility of an autonomous aerial platform natively designed to interact with other systems (uninhabited or manually piloted) in a network-centric warfare environment.

Though a great emphasis used to be placed on "autonomy", both DARPA and the services implicated in J-UCAS development expressed their will to maintain the judgment and the moral imperative of the human operator in the loop. Far from extracting the human factor from the combat cycle,

[5] United States General Accounting Office (June 2003), *Matching Resources With Requirements is Key to the Unmanned Combat Air Vehicle Program's Success*, Report to the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives, GAO-03-598, p. 8.

promoters of the J-UCAS understood the necessity to preserve human intervention inside the architecture.

Among the imperatives formulated by its conceivers, cost saving was one of the most important objectives of the J-UCAS. This is the reason why J-UCAS was to use a Common Operating System (COS) to facilitate the integration of subsystems such as sensors, weapons and communications. J-UCAS also was designed to ensure intra-operability between its internal components and interoperability with external combat systems such as unmanned and manned aircrafts, C^3 centers or space assets. To this aim, the DARPA awarded John Hopkins University Applied Physics Laboratory a $26.9 million contract to integrate the COS into the J-UCAS system[6]. The quest for commonalities between the two air systems was indeed critical. Since their inception, both the USAF and the USN projects attested of similar technical challenges.

On an organizational level, the J-UCAS program combined the efforts previously conducted under the DARPA/Air Force UCAV Program and the DARPA/U.S. Navy naval UCAV-N project. It is the potential for significant synergy between the two systems – initially developed in order to target each of the service-specific needs – that convinced the Department of Defense (DoD) to combine the abovementioned programs. On an industrial level, the J-UCAS consisted of two technological demonstrators, respectively the X-45 and the X-47. The U.S. Air Force selected Boeing to build conceptual airplanes – the X-45 – for defence suppression missions. In a first block of testing and development – designated Spiral "0" – two X-45As were build. The first flight occurred in May 2002. Such a test demonstrated the basic functionality of the C3 and navigation systems. It also confirmed the validity of the aerodynamic envelope required for future test-flights[7]. For its part, the U.S. Navy decided to

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[6] *John Hopkins University To Coordinate J-UCAS*, Jane's Defence Weekly, 41(41), October 2003.

[7] J. A. TIRPAK, *Toward an Unmanned Bomber*, Air Force Magazine, June 2005, p. 45.

choose Northrop Grumman for the conception of the X-47. The X-47 was not expected to address the same requirements as those of the X-45. The platform developed by Northrop Grumman, in accordance with the U.S. Navy, was to demonstrate low-speed handling qualities, air vehicle performance and navigation performance. The first flight of the X-47 took place in February 2003.

In order to fulfill the above-mentioned requirements, 15 critical technologies and processes were identified. In order to gauge the level of maturity of the program, these critical technologies were classified according to their degree of risk. At that time, 10 of the critical technologies identified were considered to be medium risk by the USAF and DARPA. A medium risk technology means that there was a 30 to 70% probability to achieve the desired functionality. The last five critical technologies were considered to be high risk. In other words, there was less than a 30% of probability to see these technologies evolving to the required functionality.

4. LOOKING FOR JOINTNESS

Military-technological innovation in peacetime has always proved to be a very risky exercise for defence establishments anchored in the Western "weapon system" culture. Indeed, as Mary Kaldor used to write: "*In peacetime, in the absence of external necessity imposed by war, decisions about what constitute technical advance are necessarily subjective. They tend to be taken by people who make and use the weapons systems, whose ideas are necessarily shaped by institutional experience and interest in survival*[8]." Consequently, "*the system is almost completely introverted, concentrating on the perpetual perfection of itself against some future day of judgement*.[9]" This is what Mary Kaldor means by "baroque technology".

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[8] M. KALDOR, *The Baroque Arsenal*, London: Andre Deutsch, 1982, pp. 18 – 19.

[9] *Management in the Armed Forces: An Anatomy of the Military Profession*, London: McGraw-Hill, 1977, p. 195.

Though technical challenges related to the original version of the UCAV program were very high, additional requirements were expressed by the USAF, thus challenging the ability to make the resources matching with the defined functionalities. Subsequent requirements included an electronic attack mission capability and an increased combat range and survivability. In December 2002, confronted with such an ever increasing catalog of requirements emanating from the Air Force, the Office of the Secretary for Defense (OSD) invited the managers of the program to envisage a combination of USAF and Navy efforts regarding the development of UCAV capabilities. In June 2003, the OSD decided to establish a Joint Systems Management Office for the UCAV program. Progressively the UCAV program, predominantly funded by the Air Force, evolved towards a joint effort under the auspices of the DARPA. Yet, the DARPA was not necessarily the most logical choice in this regards. The main mission of the Defense Advanced Research Project Agency resides in innovative concepts validation. Such a program, at that stage of development, should have normally nothing to do inside DARPA. Several explanations were mentioned in order to justify the choice of DARPA as the main manager of the J-UCAS. First, many of the technologies (low-cost, compact, high speed computing, digital wireless communications, smart algorithms, artificial intelligence, etc.) required to advance J-UCAS were started at DARPA. Second, DARPA had an extensive heritage in combat systems development and information technology capabilities over many decades. It would have been surprising to build a future unmanned combat aerial system without building on DARPA's expertise in those domains. A third explanation can be found in DOD's fears to see the USAF dismantle the J-UCAS program. At the end of 2002, a report from the Pentagon's Plans, Analysis and Evaluation Office depicted the J-UCAS as a potential substitute for the F/A-22. These allegations – though they clearly provided evidence of a grave misunderstanding of the very objectives of the technological demonstrator program – gave

rise to concerns among the DOD that the USAF could be not as supportive as expected of the J-UCAS project.

Coordination of research efforts of both the USAF and the USN regarding UCAV development never gave birth to a common catalog of requirements. Moreover, it can be said that the decision to join the USN, the USAF and the DARPA together for the set up of an interservices project led to increasingly more demanding performance specifications. It soon appeared that the original rivalry between the USN and the USAF regarding the operational specifications of the UCAV project perpetuated, even under the auspices of the then J-UCAS Project Office (JPO)[10]. Such a trend can be explained on the ground of experience cumulated with past military programs. According to Matthew Evangelista, the weapons innovation process can be divided into four stages, respectively labeled as (1) *technocratic innovation,* (2) *consensus building,* (3) *promotion and* (4) *open windows*. It is interesting, here, to focus on the two first phases described by Evangelista.

In a first phase, it appears that because innovation begins not in a decision at the higher level of political decision making, the resolution to invest in a new technology is often "technocratic" in its essence. At the early stage of weapons innovation, external threats – actual or perceived – have not much to do with the decision to explore new military technologies. In its second phase, an innovation process has to build consensus. Because "*technology is not an autonomous force […] If an idea for a new weapon is to attract political support and funding, it must have promoters*.[11]" Still according to Matthew Evangelista, consensus building is characterized by two practices. A first practice is the inability – and, maybe, the absence of will – to limit technical options. A second practice resides in the tendency on the part of

[10] The J-UCAS Project Office opened in December 2002. It was the result of the decision taken by the Office of the Secretary of Defence to combine the two services efforts under a single direction.

[11] M. EVANGELISTA, *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies*, Ithaca and London: Cornell University Press, 1988, p. 56.

the promoters to accept all specification requirements expressed by the services supposed to be interested in the acquisition of the new technology. This is the reason why consensus building often leads to the development of weapons of greater technical sophistication than is desirable for a given military mission.

5. A COMMON OPERATING SOFTWARE

"*Whatever the form that these future air vehicles take, one constant that will remain is the revolutionary software system designed to integrate the J-UCAS system elements*", Michael S. Francis and Michael J. Hirschberg wrote in an article of RUSI Defence Systems. To put it differently, promoters of the J-UCAS program were firmly determined to bridge the actual gap between the industrial age platforms and the network-centric architectures that are expected to dominate the 21st century battles[12].

Put differently, the J-UCAS was deliberately built as a software program. Put differently, the software was expected to be the core of the program. The J-UCAS was not developed to become a "*single, one-size-fits-all airplane for all missions*", according to Michael S. Francis. He added: "*some will be designed with heavy emphasis on stealth, while others may emphasize range or payload or persistence*."

What was particularly striking about the J-UCAS project is that it involved a brand new and different way of thinking about the process of engineering development. The new approach, called "spiral development", consist of a series of rapid design-and-build cycles in which the lessons of earlier spirals can be incorporated into the next. As it can be seen, spiral development differs fundamentally from previous methods of development for it is not axed around the settling of a final design to be build. The choice of the spiral model of

[12] M. S. FRANCIS, M. J. HIRSCHBERG, *J-UCAS: Inventing a Weapon System for the Information Age*, RUSI Defence Systems, Summer 2005, p. 69.

development is not fortuitous for it was specifically selected in order to help managing risks linked to large, expensive and complicated projects. The Spiral Model, also known as the Spiral Lifecycle Model is, at its origins, a systems development lifecycle developed by the mathematician Barry Boehm. Today, it is used in information technology (IT).

As a result, the J-UCAS was conceived less as an airplane than as a networked information system. It could be added that the vehicle was merely the host around which the system was built. In that sense, both prototypes (the X-45 and the X-47) had to be envisaged as software development tools.

Several spirals of development were defined in order to test specific technical objectives. In Spiral "0", individual programs, not yet clustered under the common J-UCAS designation, were based on the more advanced existing platforms, that is the X-45A UCAS and the X-47A UCAV-N). The Spiral "1", under the J-UCAS program, was intended to design, develop, integrate, and demonstrate the technologies, processes, and system attributes (TPSAs) pertaining to the J-UCAS Operational System.

Spiral "2", originally expected to take place between 2007 and 2009, had the objective of developing and testing greater operational utility. Results following Spiral "2" were supposed to lead to the development of the J-UCAS Objective System (J-UOS). Due to the premature termination of the program in February 2006, the J-UOS was never reached.

6. J-UCAS GREW FAT

What was once expected to be a low-cost counterpart to the manned fighter rapidly evolved towards a huge air system designed to address diverse – if not conflicting – requirements[13]. Paradoxically, additional requirements

[13] SWEETMAN, B., *UCAVs Grow Fat on Requirements*, International Defence Review, 36(5), May 2003.

regarding the level of performance and endurance of UCAV – mainly due to Air Force pressures – contributed to place the J-UCAS in a competition with manned aircraft programs such as the F-22 or the F-35. According to Michael S. Francis, who directed the J-UCAS program, "*a substantial effort [was] applied to keeping the system affordable and ensuring that it doesn't duplicate or replace anything else*.[14]" If J-UCAS program director seemed to admit that UCAV used to be in a competition with the F-22 and the F-35, he insisted that it was "*only for money*"[15]. Considering the risk for J-UCAS to be in direct competition with major programs as such as F-22 and F-35, DARPA argue that, from its inception, teams in charge of the J-UCAS have focused on conducing technological demonstrations. The goal was not to anticipate the exact needs of the services because these needs tend to fluctuate with time. In other words, the program as a whole may have been considered as a test-bed for multiple acquisition programs depending on the services ambitions.

At the end of 2004, during a presentation given at an IQPC Defence conference specially dedicated to UCAV issues, representatives of Northrop Grumman admitted that the company was looking at the development of UCAVs with a 4.5 – 7 tons weapon load and a maximum take-off weight of 45 tons or more. In addition, it was expected to study the possibility to design vehicles able to fly missions of more than 50 hours. According to Northrop Grumman, these requirements, expressed by the U.S. Air Force, were intended to fill what has since been called the "supergap", that is the inability for existing advanced fighter and bombers to target increasingly capable mobile systems (i.e.: surface-to-air missiles, theatre ballistic missiles) deep inside the enemy's territory[16]. A scaled-up UCAV could operate at a range similar to that of the B-2 (from 5,400 to 10,800 km) and to fly well beyond the limits

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[14] TIRPAK, *Toward an Unmanned Bomber.*, p. 46.

[15] TIRPAK, *Toward an Unmanned Bomber.*, p. 46.

[16] *USAF Demands Larger UCAVs*, International Defence Review, January 2005.

of human performance thanks to regular air-refueling. However, such an UCAV would be limited to carrier compatibility, though it was not impossible to imagine a family of UCAV bomber designed to operate from land bases.

Such an evolution was expected to alter the U.S. Navy ability to imprint on J-UCAS orientation. Historically, USN considerations towards projects aimed at the development of unmanned air platforms reveals some paradoxes. Initially, the U.S. Navy showed practically no concern regarding the conception of unmanned aerial systems. In fact, the USN soon realized that there were no conceivable circumstances under which its service could put more than a handful of UCAVs on each of its aircraft carriers. In other words, the number of unmanned air combat vehicles needed by the USN was too few to justify a standalone program specifically dedicated to naval needs. The conclusion drawn by the Navy was thus that without a joint program, the Navy would probably not have a UCAV at all.

This is not to say that the Navy did not express its own views on the J-UCAS project, once it has been put on the track. Yet, once the J-UCAS has been placed under the management of the JPO, visions expressed by the Navy about future J-UCAS missions proved to be extremely impressive. Whereas the Air Force envisioned the unmanned platform as a system mainly dedicated to the suppression of enemy air defence (SEAD) – that is, a "first day of war" enabler –, the USN, initially, saw in the J-UCAS a platform – that is the X-47 conceived by Northrop Grumman – especially dedicated to intelligence, surveillance and reconnaissance (ISR) missions. The goal of the USN was to provide its carriers with survivable and persistent autonomous platforms to complement manned assets and long range precision strike weapons. It is only in a later phase of development of the J-UCAS that the Navy eventually decided to integrate strike capabilities to the platform. However, by designing the X-47 for strike capabilities from the outset and by postponing the ISR capabilities to future development spirals,

the Navy contributed to severely increase the degree of technical sophistication of the projected platform. The industry clearly realized that UCAV developers would have to make trade-offs between survivability, onboard sensor suites and strike assets.

Another part of the X-47 program was to evaluate the feasibility of an autonomous, precision-guided landing on aircraft carriers. The objective of the Navy was to fit the X-47 with a new carrier landing system, the Shipboard Relative Global Positioning System (SRGPS), aimed at succeeding to the then actual Automatic Carrier Landing System (ACLS) used for many years by the U.S. Navy for its piloted aircrafts.

It clearly appears that the cost-saving criteria would be very difficult to address. In 2003, the DoD expected to spend US$3,9 billion on the projected UCAV (USAF) and UCAV-N (USN) by fiscal year 2009 (FY2009). In its roadmap, DoD predicted that UCAVs would cost less than the F-35 per pound of payload carried (US$5.500 vs US$7.300). However, final prices depend on the number of UCAV ordered. For the Navy, it was very difficult to determine its exact needs. Due to technical and platform limitations, it was not possible for the USN to allocate more than six vehicles by carrier. It was thus dubious to see the Navy express a need for more than 100 UCAVs. Regarding the U.S. Air Force, a total command of 150 units was considered as the maximum possible. As a result, the expected total number of acquisitions by both the USN and the USAF was not sufficient to determine the exact unitary cost of J-UCAS platforms.

Operational costs were also an issue. According to one USAF officer, the need for the development of mission control systems on the ground could make the UCAVs more expensive to operate than manned aircrafts. All these elements contributed to demystify cost-saving perspectives initially promised by UCAV advocates.

7. TERMINATION AND REVIVAL

As it is known, due to budgets cuts, priority changes and, probably, management divergences, the J-UCAS program was cancelled in the first half of 2006. In fact, forewarnings of a probable termination of the project led jointly by the DARPA, the USAF and the USN occurred as soon as the DOD decided in 2005 US$ 1 billion cutback. Though some observers at the time argued that the project could survive the next QDR, the DoD decided, in 2006, the demise of the J-UCAS. Yet, J-UCAS's death did not mean that the services abandoned the idea to develop UCAVs in the future: "*J-UCAS was cancelled, but the technologies have survived*.[17]" Moreover, the QDR did not speak of a "clear-cut" termination when evoking the future of the J-UCAS program. Rather, the 2007 U.S. defense budget redirected the program's funding to a vaguely defined "Next Generation - Long Range Strike" (NG-LRS).

The U.S. Navy was the first to regenerate the project of an unmanned aerial system; this time, exclusively designed for carrier-based operations. Boeing – with its X-45B – and Northrop Grumman – proposing the X-47B – submitted bids for the USN project. In 2007, the Navy awarded a demonstration contract to Northrop Grumman in order to manufacture an inhabited air vehicle for operations from the deck of an aircraft carrier. The X-47B was thus resurrected by the company which gave it a brand new label: the Unmanned Combat Air System - Demonstrator (UCAS-D). The U.S. Navy proved to be very conservative as regards to the requirements defined for the technology demonstrator. It must be noted that the USN planned a 6 years demonstration phase (stretching from 2007 until 2013) and did not make any commitment to pursue the UCAS-D program beyond its prototype phase. Could this situation change? According some observers, the U.S. Navy and the U.S. Air Force are in discussions on reviving collaboration

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[17] *Carrier UCAVs: The Return of UCAS*, Defense Industry Daily, http://www.defenseindustrydaily.com/?s=j-ucas.

on building stealthy, unmanned combat air systems, more than three years after parting ways. Things remain to be confirmed during further talks[18].

Notwithstanding USN allegations, it appears that the service requirements as regards to the UCAS-D specifications have not been notably lowered in comparison to J-UCAS X-47 ambitions. The USN is still on track to develop with Northrop Grumman an unmanned low-observable aircraft capable of undertaking surveillance and precision strike missions at high subsonic speeds from aircraft carriers. A special emphasis was placed on air-to-air refueling (AAR) which was considered as a critical capability for the UCAS-D. A test-flight, aimed at demonstrating the AAR ability, was originally expected to take place in November 2009 at Edwards Force Base. It has recently been postponed to the first half of 2010. That flight should mark the beginning of a two years flight envelope intended to certify aircraft carrier operations. A second series of tests, expected to take place in the current of 2010, will be performed using a surrogate aircraft with AAR equipment. AAR flight tests using the X-47B platform are not expected to occur before 2012.

On Air Force's side, calculations regarding the future of unmanned combat aerial vehicles were somehow jeopardized due to the financial charge associated to the final phase of development of existing new generation fighter's programs (as such as the F-22 and the F-35). It also must bee added that worries as regards to the definition of the NG-LRS have questioned the USAF's middle to long term vision.

Shortly after the demise of the J-UCAS technological demonstrator, the USAF decided to initiate an Analysis of Alternatives (AoA) process intended to determine whether its future long range bomber will be manned or unmanned (or

[18] S. TRIMBLE, *USN*, *USAF Holds Talks on Stealthy UCAV Link*, Flight International, London, Aug 25-Aug 31, 2009, 176(5203), p. 14.

both) and whether or not it must be supersonic[19]. The Quadrennial Defence Review, which was published in February 2006, clearly expressed the need to accelerate the launch of a NG-LRS for the U.S. Air Force. Regarding the future of long range bombers, the QDR 2006 stated:

"*The Air Force has set a goal of increasing its long-range strike capabilities by 50 per cent and the penetrating component of long range strike by a factor of five by 2025 […]. Approximately, 45 per cent of the future long-range strike force will be unmanned.*[20]"

Though the QDR was apparently unequivocal about the necessity to speed up efforts to develop a new land-based, penetrating long-range capability by 2018, the DoD soon revised its judgment by estimating that there was non near-term requirement for a new bomber, since the existing fleet would satisfy the requirements through around the year 2035. Recently, on 10 March 2009, the Office of Management and Budget gave the Pentagon guidance to cancel plans for a new long range bomber. This decision was a drastic setback for the U.S. Air Force which, in 2008, convened that it should need a new bomber, given the fact that the modernizing of legacy bombers would not suffice to meet its operational requirements.

Does such a decision put a definitive end to UCAS development? According to some analysts, one must suspect that the USAF simply took its armed drone development plans into the black world.

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[19] *UCAVs Offer Fast Track To Stealth, Long Range and Carrier Operations*, International Defence Review, 40(1), January 2007.

[20] B. SWEETMAN, S. TRIMBLE, S., *Few Signposts for LRS*, Jane's Defense Weekly, 43(30), July 2006.

8. CONCLUSION: HAS UCAV BECOME ANOTHER "GOLD-PLATING" TECHNOLOGY?

Alongside cost overruns, questions were expressed as the precise future roles of J-UCAS platforms in future warfare. Unknowns regarding the expected operational benefits unmanned combat aerial platforms could bring were resumed to a joke expressed by a USAF official: "*Everyone agrees that UCAVs are the answer […]. We just have to figure out what the question is.*[21]" The lack of a precise mission for UCAVs largely contributed to drive the size of the J-UCAS upwards.

Questions still remain about whether there is a fundamental operational requirement for UCAVs. Some observers of military affairs do not hesitate to allege that other types of weapons, such as cruise missiles or stand-off weapons launched from habited platforms could do the same job in a more cost-effective way. In other words, rather than asking whether UCAV is the best cost-effective solution for meeting the defined mission requirements, the services were likely to push for the greatest possible performance regardless of cost.

This has not proved to be a viable strategy for UCAV developers. Looking back, it appears that both the USN and the USAF never defined precise needs for a common unmanned combat aerial system. As a result, the Department of Defense never obtained a clear demonstration of the need to pursue investments on J-UCAS. Needless to say, each service has a share of responsibility for the program's failure. The U.S. Navy came lately with its vision about UCAV. Moreover, it has never decided how many aircrafts it would need. The U.S. Air Force failed to fix definitive technical specifications. But there's more: as remembered a Jane's Information Group editorialist, "*there has been at least five different plans for building the UCAS into the*

[21] B. SWEETMAN, *Revolution of Curiosity? UCAVs Wait for a Mission Statement*, International Defence Review, 38(12), December 2005.

USAF". Unsuccessful attempts conduced by both services in order to define J-UCAS technical specifications tend to prove that new technology does not necessarily change neither people's identities nor institutional cultures.

Given the information available, neither was J-UCAS a technological breakthrough in armament nor an innovation in the way military programs should be managed. Instead, it could be argued that the program was a direct legacy of the Western "weapon system" culture criticized by analysts for it usually leads to mission requirements inflation, cost-overruns and extremely complex management architectures.

It is currently very difficult – if not impossible – to draw clear perspectives regarding the future of unmanned combat aerial systems. Like any other military technology, UCAV is at the center of a worldwide mimetic process that currently leads some military powers to develop their own systems (Russia, India, etc.). Whether these projects will get to concrete operational results is far from sure. One thing is, however, sure: the proliferation of such systems may well be the trigger of a new qualitative technological race. Such a race could accelerate future investments in favor of unmanned combat aerial systems, even though these platforms have a limited window of opportunity to find their exact missions.

Finally, the incidence of strategic and technological cultures on weapons development in the U.S. must be stressed if one attempts to understand the J-UCAS's program cancellation. One has to remind that the U.S. armed forces, when developing disruptive military technologies, have always proved to be particularly shy in the definition of a stable weapon configuration. This was especially obvious as regards to the conception of UAVs. The contrast with the development methodology of unmanned systems in Israel is particularly insightful. Contrarily to the U.S., Tsahal never had neither the budgetary means nor the strategic depth in order to pursue the development of large and complex weapons systems involving long cycles of development. This was much even true regarding

unmanned platforms. Given the threat to its survival emanating from its direct and indirect neighbors, Tsahal did not have other choice than to pay attention to precisely defined military systems: that is, "good enough" style armaments or weapons systems surrounded by a clear and well disseminated doctrine through their armed forces. A glance at the history of UAV development in the U.S. shows a dissimilar phenomenon. Given their relative geographical insularity and their air superiority, the United States have never felt geopolitical pressures to define precise and definitive configurations for its new armaments. This was especially true as regards to UAV and UCAV technologies as the J-UCAS has tended to prove.

Map

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Contact

Royal High Institute for Defence
Renaissance Av. 30
1000 Brussels
Website: http://www.mil.be/rdc
Email: irsd.conferences@mil.be
Phone: +3227426995

Access

Our offices are situated in the center of Brussels, near the Jubilee Park and the European institutions.

Subway : lines 1A et 1B (stations “Schuman” or “Merode”)

Bus (STIB) : line 63 (bus stop “Gueux”) – line 61 (bus stop “de Jamblinne de Meux”)