The Early Evolution of the Predator Drone

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Editor's note: The author, as a senior officer of the CIA's Directorate of Science and Technology, was Director of Central Intelligence James Woolsey's staff officer for the Predator project. Among his duties was the conduct of a detailed operational evaluation of the Predator's initial deployment. Woolsey served as the DCI from 5 February 1993 to 10 January 1995.

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> ***"The history of one government project, the GNAT 750, and its rapid evolution into today's Predator UAV demonstrates that fiscal austerity can be an innovator's opportunity."***

Innovations in national security capabilities need not decrease during times when security needs collide with austere budgets, and government and industry leaders must continue promoting innovation even as budget cuts drive reductions in some capabilities.

The history of one government project, the GNAT 750 and its rapid evolution into today's Predator UAV —America's first operational long endurance unmanned aerial vehicle (UAV) or "drone"—demonstrates that fiscal austerity can be an innovator's opportunity. The opportunity, however, is only recognized and realized by teams of people with extraordinary combinations of leadership, commitments to missions, technical know-how, and bureaucratic savvy.

To examine these principles in practice, one need only look back to the most recent period of substantial cutbacks in national security spending, the early 1990s.[1] The historic image of freedom-loving Germans, making good on President's Reagan's injunction to "tear down this wall," was emblazoned in everyone's memory as the 1990s got underway.

US intelligence, essential to preserving the peace in the decades of Cold War, did not stand down when the Berlin Wall came down, however. In his now often-quoted observation at the time, DCI-designate R. James "Jim" Woolsey, summarized the situation during his confirmation hearings: "We have slain a large dragon. But we live now in a jungle filled with a bewildering variety of poisonous snakes. And in many ways, the dragon was easier to keep track of."[2]

Woolsey correctly envisioned continued threats to the United States, her friends, and global security and

[1] See www.whitehouse.gov/omb/budget/Historicals for graphic overviews of the immediate post-Cold War budget situation.

[2] Douglas Jehl, "CIA Nominee Wary of Budget Cuts," NY Times, 3 February 1993.

stability. Nevertheless, political leaders in the White House and Congress were eager for a peace dividend on the tremendous investments made in security during the Cold War.

The "snakes" stirred quickly. In 1990, the six regional republics and two autonomous provinces of the Socialist Federal Republic of Yugoslavia—held together for decades by Tito's rule—began to unravel in a series of secessions beginning with Slovenia in December. Croatia, Macedonia, and Bosnia soon followed with their own secession referendums in which overwhelming majorities voted to separate from Yugoslavia.

The ensuing war between hostile ethnic and national groups in Bosnia resulted in at least 100,000 people killed, many of them civilians. Ethnic cleansing of entire towns created refugees, forcing perhaps as many as two million civilians from their homes.

When cities, towns, and villages experience war fought not only by uniformed soldiers but also by former neighbors dressed mostly in civilian garb, the result is a complex human terrain that adds to the inherent fog of war. During the war in Bosnia, the US government was challenged to sort out what actually was happening amidst the often conflicting claims of Serbian, Croatian, and Bosnian Muslim authorities. US government leaders, starting with the president, demanded accurate information on the situation.

Gathering intelligence over Bosnia was complicated by its relative size, roughly equal to the state of West Virginia, mountainous terrain, and heavy cloud cover, especially in the winter months. The most precious intelligence capability needed in Bosnia, however, was the ability to hold specific areas under surveillance for extended periods of time. Continuing coverage was needed of such areas as the safe enclaves created to separate combatants and potential sources of hostile artillery fire.

US satellite reconnaissance capabilities were limited to coverage of only a few minutes each day. Understanding events on the ground required a surveillance capability that could linger or "dwell" over areas of concern for hours. The United States had no such capability and thus the answers to key intelligence questions about Serbian atrocities and military operations would contain a high degree of uncertainty and conflicting information, especially early in the war.

Enter DCI Woolsey

Jim Woolsey was sworn in as DCI a year into the war, but he came with substantial experience in intelligence capabilities, and he was aware of the potential of UAVs. Woolsey's experience in intelligence actually began in the late 1960s when Dr. Alain Enthoven, assistant secretary of defense for systems analysis in the Johnson administration, recruited Woolsey to the secretary of defense staff as an intelligence systems analyst.

As a Yale law student, Woolsey had written an article on systems analysis and program budgeting. Twenty years later he led a panel for DCI Robert Gates analyzing the future of overhead reconnaissance. During the panel's work, several intelligence experts supporting the panel further immersed Woolsey in the capabilities and limitations of reconnaissance satellites and UAVs. Taking his station at CIA, Woolsey knew right off the bat that the United States needed a long endurance UAV over Bosnia, an unmanned aircraft that could loiter over the country with a video camera for hours at a time. Like many innovations, the path to operational success was anything but linear.

The innovation arm of the Department of Defense, the Defense Advanced Research Project Agency (DARPA) actually had begun research on endurance UAVs in the 1980s in work that would make Woolsey's vision possible a decade later. DARPA contracted a company founded by legendary aeronautical engineer, Abraham "Abe" Karem, to build several copies of a prototype long endurance UAV. Karem's company would successfully demonstrate that an endurance UAV known as "Amber" could stay aloft for more than 30 hours. Ironically, the company then went bankrupt, and Amber failed to take root in any of the Defense Department's (DoDs) big acquisition programs—a fate faced by many, if not most, disruptive innovations. DoD cancelled Amber, and Karem liquidated his company, selling the Amber to a California defense contractor, General Atomics.

In yet another of the many twists and turns leading to the GNAT's breakthrough, Karem's initial relationship with Woolsey had nothing to do with UAVs but with MX missile basing. While working on a US committee examining options for MX basing, Woolsey heard Karem and a team from Boeing present an idea for a long endurance MX missile carrier that could efficiently loiter over the ocean for long periods of time. Woolsey was surprised by the vehicle's range and payload, but he was even more impressed with Karem's blend of creative engineer-

ing and technical depth. Their relationship would be a spark for the GNAT's success over a decade later.

Apart from his relationship with Karem, Woolsey had first seen video surveillance from a UAV during a trip to Israel's Galilee region in the early 1980s. An Israel Defense Force (IDF) senior officer showed Woolsey a dirt airstrip in the hills of Galilee from which an IDF Air Force unit was flying UAVs collecting video imagery over southern Lebanon. Woolsey knew that US military forces had used a number of drones in prior wars. These drones were primarily designed to fly into an airspace as a decoy or bomb without returning to their launch base.

Former DCI Richard Helms had a tongue in cheek characterization of these missions which he offered to the Woolsey panel: "We flew a lot of drones into China during World War II. I wondered if they all landed in the same pile." The video surveillance and associated operations conducted by the IDF Air Force was fascinating to Woolsey: "I had never seen anything like that before.…I was really taken by their operations and became a big UAV fan."

Woolsey first suggested the use of endurance UAV technology in 1989, when he was the US ambassador to the Negotiation on Conventional Forces in Europe (CFE). It was a suggestion that, he told me, led to some good-natured mockery from his staff. Like the requirements for surveillance over Bosnia, the CFE treaty required monitoring of cantonment areas, ensuring that the movement of conventional military forces adhered to the CFE treaty parameters. This required surveillance of areas over long periods of time to monitor hundreds of thousands of pieces of military equipment.

Woolsey thought endurance UAVs were a perfect solution to CFE treaty monitoring. Other parties objected, citing the potential for crashes and other issues. The staff would come to quip, "Whatever the problem, Woolsey thinks a UAV is the solution." The potential benefits of an endurance UAV were certainly rooted in Woolsey's mind.

As DCI, Woolsey was immediately confronted with intelligence gaps on the Bosnia War and, right after taking the oath of office on a Saturday, summoned several people to a meeting in his office. The inability of satellites to persistently stare at Bosnian safe enclaves was not surprising to Woolsey, given his background. Thus, he was convinced that the time for an endurance UAV to prove itself as an intelligence collection platform over Bosnia had arrived.

The Contribution of Abe Karem

For every leader willing to champion innovation, there must be a genius with enough technical know-how and grim determination to deliver results. Abe Karem emigrated to the United States from Israel because he thought the United States would offer a better environment in which to start an airplane company. Karem, an aeronautical genius and hands-on engineer, built the forerunner to Amber in his garage in California.

Karem knew that at the time endurance was the primary limitation of UAVs. He was determined to increase it to tens if not hundreds of hours. While Karem's company and the Amber program may have appeared as failures to some in the late 1980s, Karem had built and sold several working endurance UAVs, later to be known as the GNAT 750, to General Atomics. Hardly failures, these endurance UAVs provided the necessary UAV platform to enable Woolsey's vision to become a reality.

While the GNAT program had a powerful champion in the DCI's chair, successful innovation is rarely driven just from the top. The tributaries leading to the GNAT's success also began inside the CIA, years prior to Woolsey's arrival. For years Agency operators had been experimenting on the technologies and operations concepts that would enable the GNAT system to take flight. With Amber, Karem had built a UAV that could successfully take off, stay aloft for many hours, and safely land.

To be effective as a persistent surveillance platform, however, the UAV also had to be able to receive instructions and deliver its data from places far from its ground control site, hundreds if not thousands of kilometers away. To accomplish this, the UAV needed some type of relay to extend its range beyond the line of sight of its ground station.

Agency engineers and operators envisioned, and went to work on, this need for a relay—completely unrelated to Karem's work on Amber. While establishment of a relay seems straightforward with today's technologies, the software required to safely fly the UAV through a relay, and maintain this relationship among ground station, relay, and UAV, was hardly trivial in the 1980's. Agency employees were working on a cutting edge operations concept using unmanned and manned aircraft for testing, often with risk to the lives of the test pilots.

Ambassador Henry "Hank" Crumpton, former CIA officer and counterterrorism adviser to the secretary of state, once noted that oper-

ational breakthroughs often require people to accomplish heroic feats. Testing the CIA's relay concept required some heroism to persevere through the occasional aircraft crashes, software bugs, and aircraft malfunctions.

The heroes on this team of air operators included a heroine, Jane, a young, talented, multiengine-rated pilot and engineer whose humble demeanor belied her bravery in the cockpit and her determination to see the relay concept succeed. Through relay experimentation, Jane became a believer in the endurance UAV concept of operation. As someone who was hands-on in both the engineering of the system and operating from the cockpit, Jane represented the technical and operational know-how required to achieve success.

Jane and a team of operators and engineers had conducted a survey of industry, seeking new capabilities for the relay concept. Many of the components of the system they were working with were aging and, like many experimental systems, were one of a kind. The team recognized the need to replace these components to continue developing, testing, and proving the relay concept of operation.

With all of its technical and operational know-how, the team happened on a happy coincidence. Jane and her team discovered the Amber vehicles during their market survey. After some investigation with General Atomics, the team defined a more mature concept featuring Amber, or the "GNAT" as it had by then come to be known. The GNAT vehicle provided a much more reliable air vehicle for long endurance missions. The relay concept, and many of its components, enabled the GNAT to fly surveillance missions at extended ranges. Unbeknownst to Woolsey when he arrived at CIA, the pieces had already fallen into place inside CIA to make his UAV idea a reality. However, cultural and bureaucratic obstacles almost prevented Woolsey from learning about Jane and the team's work.

Jane and an Act of Courage

To succeed, innovations in big organizations must overcome not only technical and operational challenges, but cultural and bureaucratic barriers as well. CIA's culture is an interesting paradox of risk-taking and risk-aversion. From its origins in the Office of Strategic Services during World War II and on to today, thousands of operators have risked their lives in intelligence operations, and many have lost their lives in the line of duty. At the same time the politics surrounding national security and clandestine operations work to sow risk-aversion in CIA. Moreover, bureaucratic forces operate in the agency as they do in any large public or private enterprise. Risk aversion as well as cultural and bureaucratic forces would come into play as the GNAT moved from concept to operations.

To get GNAT off the ground, Jane had to act courageously to overcome the objections of managers who were dead set against the GNAT concept. It may be difficult to imagine, given the hundreds of Predators and other UAVs flying today, but during this period Jane and her team were suggesting a radically new order of things. There were a number of skeptics and others in opposition.

The fiercest opponent was Jane's own immediate manager. While a clandestine intelligence organization does not operate like a military command, there is a formal hierarchy and bureaucratic consequences for those who go against the grain. Fortunately, CIA's Deputy Director for Operations (DDO) Ted Price had become aware of Jane's concept and kept it in mind as a new initiative to present to Woolsey upon his taking office at CIA.

Shortly after Woolsey's arrival, Price's office summoned Jane to join the DDO in presenting the extended range UAV concept to Woolsey. This was pretty heady stuff for a CIA officer, but especially so given the open hostility of Jane's manager toward the concept. Price pressed ahead, possibly unaware of the friction within his own ranks, and had Jane brief Woolsey on the concept. Within a few minutes of the briefing, Woolsey leaned forward and exclaimed, "Hey, that is Abe's design," referring to a picture of the GNAT vehicle. Woolsey was excited about the potential to create an operational UAV demonstration in the near term.

Knowing that DoD had an active formal program for developing UAVs, Woolsey reached out to the DoD's UAV Joint Program Office to propose meeting the requirement. After a couple of weeks, representatives of the office came to CIA and offered their response to Woolsey and CIA officers. The office proposed an effort that would require more than a year of development and cost at least $100 million. DoD sometimes has the agility of a DARPA, but at other times it has the inertia one expects from a behemoth. Woolsey—never regarded as unwilling to act when immediate action was required—had a sense of urgency driven by the Bosnia crisis, against which the DoD proposal was deflating.

As the meeting ended and attendees drifted out of Woolsey's office. Jane, who had been a backbencher with no speaking role, lingered. The opportunity to demonstrate her courage was at hand. Woolsey had retreated to his desk as others filed out of his office. Jane approached his desk and said, "Sir, we can deploy the concept I showed you in well under a year." Woolsey asked a couple of questions about schedule and cost, then thanked Jane for the information.

Woolsey had his staff check out Jane's assertion. He also called Abe Karem to ask what had happened to Amber. The information Woolsey received gave him confidence that Jane's team could in fact deploy its system to Bosnia within a few months. Within available funding and authorities, Woolsey directed the CIA's operators to begin work while his staff began informing congressional oversight committees on the project. Woolsey was soon on the phone with one of the General Atomics cofounders, Linden Blue.

Known in some circles as the "Blues Brothers," Linden and his brother Neal had purchased General Atomics from Chevron. They had the foresight to subsequently purchase Karem's Amber UAVs. Linden—a Yale alum as was Woolsey, albeit one who had graduated 10 years later—was a private pilot of some fame. In 1961 Linden was forced to make an emergency landing in Cuba, just before the Bay of Pigs invasion. The accident resulted in a 12-day stay in a Havana jail. Despite this close encounter with a national security issue, Linden was not expecting a call from the director of CIA. He thought Woolsey was someone playing a phone gag. The two men sorted out the misperception, and a straightforward contract was soon closed to fly an endurance UAV over Bosnia.

General Atomics brought Karem in as the expert adviser on the project. Karem was elated: "I finally have the operator as my customer." Karem, Jane, and the entire government-industry team formed the kind of strong partnership essential to moving an innovative concept into operations. Karem would regularly force Jane to think with questions like, "How are we going to fail?" That question would soon prove prophetic.

The team was working feverishly not just to insert the GNAT into the relay concept of operation, but also to further develop the GNAT into a system for long-endurance surveillance operations. Much of this maturation required software enhancements to components such as the GNAT's flight computer. The General Atomics team was making these software enhancements and many other changes to the hardware, while simultaneously test flying the system. Thus, on a clear sunny day one of the two GNATs procured for the operation inexplicably crashed in the California desert (see below). A gloom immediately fell over the team and some critics were visibly pleased.

A meeting was scheduled with Woolsey to review the situation. Jane's risk averse management seized the opportunity to recommend slowing down the deployment. Woolsey was undeterred, however, and reflected Karem's summary of the situation: "No need to notify next of kin for this crash." The team quickly determined that the flight computer software was the root cause of the accident. The technical leaders at General Atomics put tighter configuration control and test procedures into place but did not slow down the pace of development required for a near-term deployment. The CIA and General Atomics reached another agreement on a second aircraft, and the project was back in business.

The ingredients were falling into place—a pressing mission need for information; committed leadership at the top and within the ranks; technical and operational expertise; and a lean government-industry partnership with the desire and resources to get the job done quickly. A CIA and Gen-

eral Atomics team were called on to rapidly implement, test, and secretly deploy the concept of using unmanned and manned aircraft to collect and relay imagery. The DCI, his senior operations officer, and the DCI's staff understood the imperative and employed bureaucratic savvy to make it happen. Within months it was clear that the recipe worked as the United States had real time information that provided greater clarity for the peacekeeping operations.

Watching real-time video from his headquarters in Washington, Woolsey was elated by the program's responsiveness and operational performance in Bosnia. The CIA operators had negotiated rights to operate from a remote airfield for what amounted to a truckload of supplies. Officers deployed with everything required fitting into a single C-130 flight.

An endurance UAV, developed and deployed in roughly six months, was flying over Bosnia providing motion imagery of events on the ground. From his office at Langley, Woolsey watched foot traffic over a bridge in Mostar and communicated with the ground station through an early form of chat software. Woolsey realized that it would not take long before military analysts, operators, and commanders would be able to command motion imagery feeds, such as this one, on targets of interest.

The operational demonstration was accompanied by a partnership with DoD to transition the GNAT to the Defense UAV program office. The Joint Staff J-2, RAdm. Michael Cramer, assigned a UAV expert from his staff, CDR Steve Jayjock, to ensure a close partnership between CIA and DoD. Decades before the GNAT, another major aviation innovation, the U-2 reconnaissance aircraft, went through a similar transition. General Curtis LeMay, Commander of the Air Force's Strategic Air Command, remarked on the U-2 development, "We'll let them build it, then we'll take it away from them." While inter-organizational partnerships are rarely devoid of parochialism, especially over a hot new capability, this UAV partnership proceeded more or less smoothly. The operational and technical lessons learned, along with the technology and a mature industrial base, were transitioned to DoD.

The DoD UAV program office, having previously proposed a lengthy and costly demonstration, suddenly was positioned to move quickly on the GNAT's success. An Advanced Concept Technology Demonstration (ACTD) was awarded to General Atomics. The General Atomics team went to work on what would become the Predator UAV system. In just six months, the GNAT's fuselage and wings were extended, and a new engine was installed.

The General Atomics team also achieved another historic first for UAV flight, the use of a satellite communications link between the ground station and UAV. The new UAV would have substantially greater range and payload. This new capability needed a new name. The General Atomics team held a competition among the engineers, and the winner was Predator.

While the initial GNAT deployment produced modest intelligence value, years later the Predator would prove essential in military operations in Iraq and Afghanistan. It is fair to say that the Predator's operational successes, and much of DoD's dependence on UAVs for intelligence today, are outgrowths of the GNAT's success over Bosnia.

In Sum

In the face of today's fiscal situation and inevitable budget cuts, many will naturally conclude that fiscal austerity will depress innovations in national security capabilities. The nation's breakthrough in long endurance UAV operations proves that this need not be the case. On the contrary, the GNAT program clearly demonstrated that innovation of historic impact can emerge from austere times such as these.

The global security environment remains highly volatile in many regions and countries. The missions of intelligence, understanding this changing world, warning of impending crises, and supporting a range of security actions are as important as ever. Americans rightly yearn for peace, but history teaches us that we must remain prepared for conflict.

In times of great mission needs and fiscal austerity, innovators can come to the fore through leadership, mission commitment, technical and operational know how, and bureaucratic savvy. The historic innovation that is the UAV is ultimately a story about the power of three leaders working together to bring an idea into operational reality. Asked once whether he was the father of the Predator, Woolsey replied, "No. Karem was the father; Jane the mother; I was simply the *shadchen*."

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