Viewpoints

Inner Lights: The Sources of Insight and Innovation Within Air Forces

By Dr Robert C Owen

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Introduction

The organisers of this conference have done a nice job of packaging the question I am addressing in this short talk. Their question is *whether or not* our historical experience suggests that "fighting systems" have been the key inspirational factor for air power practitioners that encourage innovation from within. By narrowing the focus down to what I presume to be *uniformed* "air power practitioners" and innovations directly affecting the operational effectiveness and sustainability of air forces, they have framed an important question we can deal with sensibility in a short discussion.

So, let me clarify my purpose for the next few minutes. First, I'm going to draw some insights from a discussion of the basic question about fighting systems and innovation. Second, I'll step out of my sand box a little to answer the "so what?" question; what air forces might do in response to those insights.

I should also tell you what I am not going to do; I'm not going to discuss the barriers and hindrances to innovation. There are a lot of them to discuss; including intellectual repression, senior leader dogmas and wooden headedness, institutional self- protectionism, corruption, over structured innovation cultures, and poor identification and incentivisation of innovators. I am also not going to say much about how to get people to really stick out their necks and innovate. Both of those topics are really seductive, but incorporating them would make my presentation unwieldy. So, in an amazing display of scholarly self-restraint, I will actually try to stay on topic and rely on others to start up those conversations.

Definitions

To begin, let's be clear about or at least arrive at a working agreement about the meaning of "fighting system." Frankly, I like the Air Chief's definition of fighting system as something that "harnesses technology, people and the organisation to deliver a decisive military output." On its face, this definition is more *operationally* focused than the more traditional and *logistically*-focused notion of "weapon systems" found in the U.S. Dictionary of Military Terms, which describes them as "a combination of one or more weapons with all related equipment, materials, services, personnel, and means of delivery and deployment required for *self-sufficiency*." Put another way, "weapon system" encompasses the things needed to make a particular weapon, such as a fighter, usefully operable; while "fighting system" is more about bringing together the wide range of things necessary to accomplish an important mission.

The Royal Air Force's creation of the world's first comprehensive integrated air defence system (IADs) on the eve of the Second World War exemplifies the meaning of "fighting system" and its difference from "weapon system." The RAF IADs, sometimes called the "Dowding System" after its chief proponent, Air Chief Marshal Sir Hugh Dowding, met all the definitional elements of a "fighting system." It had a clear deliverable; blocking or at least blunting air attacks on the British homeland. It was an amalgam of many weapon systems; each distinct, logistically

self-sufficient, and justified by its ability to perform a specific task within a broader operational system. Indeed, the Battle of Britain IADS was the consequence of a whole-of-nation effort to fight an air campaign on the RAF's terms. Its primary weapon systems included aircraft, perimeter surveillance radars, an extensive ground observer system, operational command centres, specialised bases, dedicated communications networks, balloon barrages, and anti-aircraft artillery. Each of these systems was supported by its own network of scientific, manufacturing, logistics, and personnel systems. In sum, the root systems of these support networks spread throughout Britain and in fact the world.

It is also important to recognise that, as an amalgam of components, a fighting system is a flexible and often transient thing; its pieces can be reshuffled to accomplish other missions or outputs. The Hurricanes and Spitfires rising to meet Luftwaffe bombers, for example, could on other days be used to strafe invasion barges along the French coast. Such a mission shift also would entail reorienting other support elements (coastal radars, air intelligence units, armourers, etc.) to accomplish the new mission. In some cases, these mission shifts will be rapid, short-lived, and even reciprocating as organisations shift back and forth between roles and missions. As a conflict evolves over time, these shifts might be more basic and longer lasting, as in the case of England-based RAF forces shifting from a primarily defensive posture in the latter half of 1940 to an offensive one from 1941 and onwards. Indeed, a competent air force's ability to quickly shift its orientation and structure from one fighting system to the next is the foundation of one of air power's key attributes – flexibility.

The Sources of Insight and Innovation

Fighting Systems

It requires only a shallow reading of the history of air warfare to see that efforts to accomplish missions have resulted in visualisations and creations of fighting systems. These can be pre-planned and centrally-directed efforts, such as the creation of the USAF Strategic Air Command in the 1950s. They can be done on the fly (pun recognized) such as the organization of the British power-projection fighting system during the 1982 South Atlantic War. But, once they are in existence, the ends of preserving and improving fighting systems can and do inspire innovation themselves. Most of my recent writings on air mobility force structure and applications, for example, have been driven by the importance of preserving U.S. power-projection capabilities in the face of enemies possessing significant anti-access/area denial (A2/AD) capabilities. The F-35, as another example, represents a logical step to preserve combat capabilities in ever more lethal operational environments.

But, as leaders and planners, we should also recognize that other factors have and likely will continue to inspire and shape innovation within our air forces. **The more salient of these factors include looming threats, technological opportunities, credible theories, and innovation culture.** Any useful discussion of innovation in air forces, consequently, should consider the individual and interrelated influences of these factors.

Looming Threats

Perceptions of threat and risk probably have been and remain the universal backdrop of all successful operational and strategic military innovation. It's hard to get senior leaders and taxpayers excited about alien invasions or zombie apocalypses – they want real threats in real timelines. When real and imminent threats do emerge, the military and the public, hopefully, get excited.

As an illustration, early air warfare thinkers like Billy Mitchell, Giulio Douhet, William Sherman, and Jack Slessor were all driven by the threat of repeating the attritional slugfest of the First World War. They saw strategic bombardment and what we would now call joint air-land warfare as the best means to return quick decision and mobility to military operations. Likewise, it was the threat of nuclear war that spurred the development of doctrines and weapon systems to conduct intercontinental strikes and to blunt those of potential enemies. Fear of a nuclear Armageddon drove the development of long-range bombers, computerised command and control systems, deterrence theories, ballistic and long-range cruise missiles, and so on. Once recognised, the reality of nuclear stalemate also prompted many developments in areas like conventional forces and warfighting concepts, insurgency and counterinsurgency theories, and arms control. At present, the proliferation of states and non-state entities able to strike with precision and in depth is driving much air warfare thought and innovation. We are confronted by circumstances where potential enemies can attack our networks, degrade our space systems, and strike our forces from their forward bases clear back to the front doors of their personnel. Those circumstances have obliged and continue to oblige air warfare thinkers and leaders to visualise new or refined weapon systems to keep *fighting* systems viable.

The interaction of threat and innovation obliges senior commanders and planners to take great care in how they articulate the particular threats their air forces face. Their articulations should be specific enough to focus and resource innovation on the most pressing problems faced by their services. The importance of specificity should be obvious to any air leader dealing with a combination of unlimited potential threats and finite resources; which likely will include everyone in this room. But, for those wishing a historical perspective, I would suggest the RAF's experience in the latter 1930s and NATO's experience in the 1970s and 1990s as instructive examples of the inseparable connection between well-articulated threats and on-target and affordable innovation. In the first instance, Britain built up its air defences as a counter to Nazi air power and the threat of bombing raids employing high explosives, incendiaries, and poison gas. In the second case, NATO responded to the continued improvement of Warsaw Pact mobilisation and offensive manoeuvre operations by moderately expanding forces, hardening the sheltering of aircraft and other key assets, and developing deep manoeuvre capabilities of its own.

But, threat articulations should not be so focused that they choke thought and innovation in operational areas of secondary but potentially significant importance in future operations. The U.S. Strategic Air Command's chokehold on aerial weapons development in the 1950s, for example, left USAF tactical air forces poorly equipped in the 1960s and 1970s for unconventional

war and for blunting a Warsaw Pact offensive into Western Europe. More recently, the 2009 U.S. Defense Department decision to limit F-22 production to 183 aircraft stands out as an example of an overly restrictive threat construct squelching important innovation. Publically unwilling to think beyond current events, the Secretary of Defense (SECDEF) built political support for reduced production with arguments that the aircraft wasn't relevant to ongoing counterinsurgencies and would not face equivalent aircraft anytime soon. In pressing its case, the SECDEF missed or dismissed important arguments for acquiring a stronger fleet of these unmatched combat aircraft. These arguments included the need for a performance pad to handle technological or tactical surprise, the challenges posed by networked 4th-generation fighters, the almost certain emergence of equivalent fighters in the hands of potential enemies, the aircraft's value as a medium-range, stealth bomber and ISR platform, and the diplomatic and military advantages of being able to take air control from any enemy almost instantly rather than over time. Thus, because it did not fit a policy of focusing on the threats at hand, F-22 production ended at less than 25% of the U.S. Air Force's original plans and 50% of its adjusted estimate of need.

Technological Opportunities

It is hard to overstate the relationship of technological opportunity and innovation in the history of air warfare. Indeed, this realm of conflict emerged with great suddenness in the early 20th Century in response to a single invention – the airplane. From that point on, air warfare has been shaped by incremental and sometimes revolutionary advances in aircraft designs and supporting technologies. Many milestone technologies are well known. They include radar, turbojet engines, nuclear weapons, aerial refuelling, air-to-air missiles, satellite-based surveillance and communications, and web-based command and control. Some developments were revolutionary in their times, but have faded from common memory or have lost their ability to excite wonder today. These included engine turbo-charging, lightweight very high frequency radios, high-octane aviation fuels, guided air-to-ground weapons, helicopters, solid-state electronics; pallet-based air cargo handling systems, turbofan engines, pulse-doppler radar, and others.

At any point in the timeline of air warfare, the most successful air forces usually were the ones that integrated new, existing, and refining technologies into fighting systems focused on achieving immediate and critical objectives. The 1982 South Atlantic War provides a prime example of an air force making the most of its limited technology options to play a critical role in a one-off joint fighting system able to retake a distant group of islands. Working with greater resources barely a decade later, air planners and coalition air forces in the First Gulf War combined several new technologies; notably stealth, precision-guided munitions, and advanced sensors, to push back an invader and, in the process, usher in a new era of air warfare.

One cautionary note from the history of air warfare, however, is the danger of demanding too much from even the most advanced systems. The fate of the multi-mission Lightning Bug is an

instructive example of this innovation error. As described in Tom Ehrhard's history of U.S. Air Force UAVs, the multi-mission Lightning Bug project foundered on the challenge of making a successful but simple aircraft do a complex job that pressed the limits of subsystems and available systems-integration technologies. After years of development and operational use, the basic Lightning Bug system (Figure 1) had achieved significant success performing in-and-out reconnaissance and dwelling ISR missions during the Vietnam War. But, when the Air Force attempted to repurpose the aircraft to search for Soviet ballistic missiles deep within the lethal air defence environment of Eastern Europe, it wound up with a system that was too complex and expensive to operate reliably and in appropriate numbers. Consequently, the project died because it was gold plated technologically, of questionable reliability, and not competitive with other pressing Air Force projects.[1]

Figure 1: USAF Lightning Bug. (Photograph courtesy of the U.S. Air Force)

Credible Theories

At the level of operational and strategic thought, clearly articulated and credible theoretical discussions were more important to early air power development than they are today. Between the world wars, famous and long-forgotten air warfare theorists provided rationale and direction for air power innovation and investment. From a contemporary perspective, their writings were preliminary, but they were sufficient to convince a lot of important civil and military leaders that strong air forces were necessary to win wars or at least to protect their homelands. Since the Second World War, theoretical discussions of air power generally have lost their influence, except as readings in the halls of professional military education. In the first place, apart from discussions of deterrence theory, air mobility, counterinsurgency operations, drones, and cyberwarfare, a high percentage of air warfare theories published since the Second World War are little more than rehashes of concepts raised before 1939.

Consequently, the main contributions of modern theory and doctrine studies have been to contemporise the language and context of mainstream ideas. More importantly, a century of operational experience and particularly events since the mid-1970s supersede theory as justification for continued investment and innovation in air power.

This is not to say that air force leaders should discontinue support for their air power studies centres and the like. In the first place, contemporised theoretical discussions are essential to the education of officers and sometimes as outreach media to influential individuals and groups. In the second place, theoretical discussions have great value, particularly if they are anchored on after actions reports on recent conflicts, unfolding technological and geopolitical trends, evolving historical appreciations of past events, and changes in the cognitive and learning patterns of new generations of officers. Such discussions keep air warfare thought alive and fresh, rather than dead memories in dusty books written in odd styles.

Innovation Culture

Just defining the meaning of innovation culture is a matter of wide interpretation. Cultures, all cultures, are composed of material and immaterial elements. The material elements of innovation cultures include innovative people, learning and knowledge management processes, educational institutes, study groups and centres, and organised channels for identifying issues and managing and exploiting innovations. The immaterial elements include the cognitive and learning characteristics of military institutions and their parent societies, the individual risk factors involved in voicing innovative ideas that challenge dogmas and interest groups, the individual incentives and rewards of innovative thought, the resources available to support thinking about and communicating new ideas, and the willingness and ability of leadership groups to understand and act upon new ideas. At the borderline between the material and immaterial realms of innovation are the career and informative cognitive "spaces" provided to allow creative individuals to do what they do on timelines comfortable to them. Traditionally, these "spaces" included officers clubs, squadron "bull sessions," and now they include things like blogs and online publications. A recent TED Talk by author and speaker Steven Johnson on "liquid networks" suggested creativity needs for informal channels of discussion working alongside or even within institutional and formal processes.[2] All of these and other elements are essential to producing a living innovation culture, one that produces and acts upon good ideas and that perpetuates itself. Creating and sustaining such a culture, consequently, is a resource and character challenge for any air force leadership group. But, there is plenty of historical evidence showing that air forces that rise comprehensively to that challenge do far better than those that do not.

To return momentarily to our old friend, the Battle of Britain, the impact of innovation culture on the way the Royal Air Force and Luftwaffe approached radar is well documented. Alan Beyerchen, an American historian specialising in the history of Germany and of science and society, argued some years ago that the two air forces viewed the new invention through different cultural lenses. The "offensive-minded" Germans "underrated the importance of

radar, because they perceived it as a defensive weapon." The Luftwaffe's commander, Ernst Udet, a First World War fighter ace and later stunt pilot also derided radar as something that would "take the fun out of flying." The Royal Air Force's Fighter Command, in contrast, was under the hand of the decidedly un-flamboyant Air Marshal Dowding, whose pragmatic mind immediately grasped the defensive value of radar and focused his financial, military, and scientific resources on developing it and its supporting systems. As a consequence, the Germans, who had first experimented with radio detection in 1904 and possessed radar systems equivalent to those of Britain, entered the war well behind their opponent in development of a comprehensive IADs.[3]

RAND analyst David Johnson's book on the development of tanks and heavy bombers in the interwar period provides a useful look into the impact of innovation culture differences *within* a service. In this case, U.S. Army tank development between the world wars was in the hands of the infantry and cavalry branches, each of which approached the tank as an extension of their tactics and institutional interests. The leaders of both of these branches were quick to censure any officers, including Lieutenant Colonels George Patton and Dwight Eisenhower, who proposed independent, tank-centric operations.[4] As a consequence, the Army entered the Second World War with agile but lightly armoured and gunned "cavalry" tanks and heavier and more ponderous "infantry" tanks. It had no battle tanks with the combination of speed, armour, and armament needed to fight it out with other tanks and to exploit breakthroughs. In contrast, Army airmen were in an independent branch focused on exploiting the potentials of military aviation, and they were largely free to focus their innovations where they thought appropriate. In part, their innovative freedom derived from the conjunction of their strategic bombing theories of what Mark Clodfelter calls "beneficial bombing," and the progressive ideals of humanity and efficiency prevalent in American popular culture at the time.[5] Consequently, the Army Air Corps entered the war with first-rank bomber and transport aircraft, and fighter types nearly equivalent to those of belligerents who had been fighting for two years. Summarising these different results, Johnson wrote, "the future of U.S. Army aviation was in the hands of advocates; the potential of the tank was controlled by traditionalists."[6]

Finally, defence scholar Dimetry Adamsky provides a more contemporary but equally convincing example of the impact of military innovation culture in his study of Soviet, American, and Israeli doctrinal response to the stealth-precision-control revolution in military affairs (RMA) of the 1980s and beyond. Essentially, he argued that the "technologically inferior" but conceptually-minded Soviets were the first to articulate a comprehensive vision of warfare shaped by the RMA, even though they lacked the technology to put it into effect. The Americans, who developed the technology but were slow to articulate its revolutionary impact, "discovered" and then adopted the Soviet vision, refined it, and then passed it on to the Israelis. Ironically, the Israelis had been practicing precision warfare since the early 1980s, but their tendency to promote practitioners rather than theoreticians to their higher ranks made them the last to grasp the full meaning of the RMA.[7]

Implications

So, the answer to the original question posed for this talk, *whether or not* historical experience suggests that "fighting systems have been the key inspirational factor for uniformed air power practitioners seeking innovations that directly affect the operational effectiveness and sustainability of air forces" is "yes," *generally*. But, fighting systems are rarely the only factors influencing innovation and, if all of the relevant interest groups and cultural forces are factored in, there are times when the operational and sustainability considerations of fighting systems are secondary, even minor considerations. But, our job as airmen ultimately is to fight and accomplish missions, to deliver decisive outputs. So, to the degree that we control our own innovation processes, we should at least try to keep fighting system requirements at the forefront of military policies and innovations.

Perhaps the most important step we can take toward controlling our innovation process will be to approach our innovation *cultures* as fighting systems in themselves. Just as we all know that acquiring a new fleet of aircraft is only the beginning of building a weapons system that can employ them usefully, we should also know that acquiring bits and pieces of innovation culture will not result in a system that produces and acts on good ideas in a timely manner. Such a system requires hardware, in the form of schools, journals, organisations and such. It also requires a full-up personnel plan for selecting, preparing, advancing, and retaining the right people at all levels and stages of the innovation culture. Finally, like any fighting system, our innovation cultures should be supported by doctrines, exercises, competitions, liaison, and exchange programs. Doctrines of innovation will be essential to clarifying and disciplining innovation processes in ways that do not stifle creativity or undermine the general order and discipline of our services.[8] Additionally, by diversifying the sources, opinions, viewpoints, and cognitive patterns in our service innovation centres, liaison and exchange programs will nurture their creativity and intellectual accountability.[9]

Perhaps the hardest challenge will be to infuse life and energy into our innovation cultures. People will be key to this, of course. So, air forces seeking timely and actionable innovations must learn how to reward their thinkers and innovators in tangible ways, particularly in terms of recognition and promotion. Remember, all good people ultimately are volunteers who can take their talents elsewhere. Many of your brightest and most creative people will come into the military because they are attracted to the mission and the military community, at least as they perceive it. They will leave if they feel under-appreciated, dealt with unfairly, or placed under bad bosses who just don't understand or value what they are doing. If we are smart, we won't let that happen very often.

Notes

[1] (Thomas P. Ehrhard, *Air Force UAVs: The Secret History* (Washington, DC: Mitchell Institute, 2010).
[2] See Steven Johnson, "Where Good Ideas Come From," TED Talk, retrieved May 5, 2016 from **http://www.ted.com/playlists/20/where_do_ideas_come_from**; and Adam Grant, "The Surprising Habits of Original Thinkers," Ted Talk, retrieved May 5, 2016 from

http://www.ted.com/playlists/20/where_do_ideas_come_from.

[3] Alan Beyerchen, "From Radio to Radar: Interwar Military Adaptation to Technological Change in Germany, the United Kingdom, and the United States," in Williamson Murray and Allan R. Millett, editors, *Military Innovation in the Interwar Period* (Cambridge, UK: Cambridge University Press, 1996), 265-291.

[4] David E. Johnson, *Fast Tanks and Heavy Bombers: Innovation in the U.S. Army 1917-1945* (Ithaca, NY: Cornell University Press, 1998), 75.

[5] Mark Clodfelter, *Beneficial Bombing: The Progressive Foundations of American Air Power*, 1917-1945 (Lincoln, NB: University of Nebraska Press, 2011).

[6] Johnson, Tanks, 220.

[7] Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the U.S., and Israel* (Stanford, CA: Stanford University Press, 2010), 3-5, 131-4, and throughout. See also Avi, Kober, *Practical Soldiers: Israel's Military Thought and Its Formative Factors* (Leiden, The Netherlands: Koninklijke Brill, 2015), 53-55 and throughout.

[8] For a useful and concise discussion of the value of innovation doctrine, see Thomas M. Williams, "Understanding Innovation," *Military Review*, July-August, 2009, 59-67.

[9] For insights into how diversity enhances performance in another realm of endeavor, see Sir Ken Robinson, "Building a Culture of Innovation," Alternative Education Research Organization *Education Revolution* presentation, January 28, 2013, retrieved May 5, 2016 from https://www.youtube.com/watch?v=6XqJ36xJEm4.