Air power in the 21st century: enduring trends and uncertain futures

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> There is a tide in the affairs of men.
> Which, taken at the flood, leads on to fortune;
> Omitted, all the voyage of their life
> Is bound in shallows and in miseries.
> On such a full sea are we now afloat,
> And we must take the current when it serves,
> Or lose our ventures.
>
> William Shakespeare, *Julius Caesar,*
> Act 4, Scene 3, 218-24

Introduction

The past few decades have seen the acceptance of a new calculus in the role that air power can—and will—play in the future security environment. This is the result of fundamental shifts in the character and conduct of war and the technology-aided ability of air power to rapidly adapt to emerging situations. Wars or conflicts that have been fought over the past half century have all been irregular in character even if the intensity, tempo and spread have been as much as, and at times more than, what could be termed high-intensity war.

The conduct of such wars defies an accurate description and therefore the term irregular warfare, meaning other than conventional wars, has been used. The unique combination of evolving capabilities, new operational concepts and technological opportunities has created a situation where air power has been able to overcome rapid changes in the character and conduct of war.

Even though it was conducted nearly 30 years ago, Operation DESERT STORM is undeniably a watershed moment in thinking about air power. From the enormous success of that operation in 1991, air power has been continually, and at times rapidly, evolving to an extent that some analysts have termed an 'evolutionary revolution'.[1]

This evolution of air power is still a work in progress and, therefore, the enduring trends in air power and its future perspectives are interminably

intertwined. The developments of the past few decades not only entrench the enduring trends in the application of air power but also have significant implications for the future of air power.

Enduring trends

There is no doubt that the classic roles of air power will be enduring. Changes that will take place will only be in terms of the conduct of these roles. Air superiority, long taken for granted by the surface forces of Western nations, will still be a pre-requisite for all operations to succeed. Strike operations that are time-sensitive and delivered with accuracy, discrimination and proportionality to create the necessary effect will continue to be the primary contribution of capable air power.

Responsive and adequate airlift, both for the transport of men and materiel as well as for the insertion, sustainment and extraction of Special Forces, has proven to be a battle-winning capability. Airborne intelligence, surveillance and reconnaissance (ISR) envelopes the battle space, providing information to decision-makers across the chain of command that ensures decision-superiority for the engaged forces. These roles are enduring.

The trend in the development of air power is towards making these roles more effective. For example, the enhanced range of air-to-air weapons that now reach beyond visual and sensor range automatically increases the 'air superiority bubble' that can be provided; strike capabilities have become much more accurate and responsive, cutting down the time in delivering a strike; airlift too has become faster while delivering more in one lift; and the sensor horizons of ISR assets have moved further away and become more discerning.

These trends ensure that air power is more responsive, accurate and reaches out to touch things much farther afield in a speedier manner than ever before. While these are salutary developments, the fact remains that the evolution of air power has plateaued in the past few decades. No doubt further refinements in its application will continue to be sought and achieved but air power has 'matured' as an instrument of national power projection.

Air power has always been acknowledged as being technology-enabled. However, the key to the maturation of air power has been technology-integration, rather than being purely 'enabled', mostly in the more advanced air forces of the world. The rate at which technologies and related concepts are introduced and assimilated, especially the expanding information technology, opens new opportunities for the application of air power in an increasingly innovative manner.

At the tactical level, computing, sensing and data compression will continue to change the way in which air power is applied. Further, innovations already combine different aspects of finding, fixing, tracking and neutralising a target in one platform, increasing the reliability of this process and clearly reducing the targeting cycle time. At the operational level, air power can now create the desired effects with absolute assurance and minimum collateral damage. At the strategic level, national security has become completely reliant on rapid power projection and mobility provided by air power.[2]

Since most technology-integrated air forces are inherently professional, acceptance of new technologies should not pose any difficulties. However, the new technologies that are being accepted only make the established trends in air power more entrenched, and normally do not create quantum changes in capability. They remain enduring trends in the application of air power.

Uncertain futures

In the past few decades, air power has been at the vanguard of the application of military power, especially by the more developed nations of the world. This trend is unlikely to change because of a number of factors, the most important being the question of adequate attrition tolerance, or the lack of it, because of casualty aversion in the Western world.

Air power with its promise of low casualty, at least to own forces, becomes the weapon of choice in all conflicts other than wars of necessity. Further, in all future conflicts where air power is at the vanguard, it will be required to undertake the entire range of missions that it has been fulfilling so far. In effect, even though the capabilities

will get sharpened, there will not be any tangible change to the application of air power.

The characteristics of the air environment vis-à-vis the pursuit of control of the air has always dominated the development, employment and efficacy of air power—and it will continue to define air power development. In this context, the air environment is characterised as permissive or benign, contested or denied.

In the past 50 or so years, Western nations with adequate air power have not had to operate in any other but a permissive air environment, never having to really fight to obtain control of the air. While this situation has brought in a sense of complacency, the future may not be the same. A benign air environment could become contested very rapidly, and the threats that will emerge could lead to a denied air environment. Successful air operations could become difficult at best.

The challenges that the changed air environment will present will in turn create unprecedented conceptual and technological innovation. The awareness of the possibility of the air environment changing from benign to a denied state has influenced the development of air power capabilities and already created the first 'system of systems' concept. In this concept, the air power capabilities that may have been resident in separate airborne platforms are combined in one 'system' that may not be a single platform but a group that functions as one system.

Uninhabited aerial vehicles on ISR missions, operating in conjunction with 4.5-generation strike aircraft provide an early example of this development. It is envisaged that the system of systems approach will culminate in making air power a seamless web that will not expose its vulnerabilities but will be able to dominate contested or even denied air spaces successfully. However, these developments are more applicable to improving the efficiency of operations and are not radically different in the fundamental concept of the application of air power.

Step-change functions. Only a step-change function in the capability will bring about changes to the manner in which air power is generated, sustained and employed. There are two such functions that are being developed in the realm of air power—the uninhabited aerial vehicle and artificial intelligence (AI). The uninhabited aerial vehicle, and its armed derivative (uninhabited combat aerial vehicles [UCAV]), are already operational realities—and are being perfected in their employment.

Both UCAV and AI, if and when fully incorporated into the concept of air power—meaning incorporated into the development, application and sustainment activities, will change the realities of air power as perceived today. The future of air power will be shaped by these two emerging capabilities and, since the full envelope of their capabilities is yet unknown, the future is unpredictable and therefore uncertain.

Uninhabited combat aerial vehicles

The UCAV and its employment has matured to a level that they are now routinely used to strike and neutralise time-sensitive targets, especially in the context of irregular wars. The UCAV must be seen as an uninhabited system, since it combines ISR and strike capabilities of air power in a single platform.

The ability of UAVs to loiter at will for a long period of time, removed from the constraints of human endurance, is optimally merged with precision-strike capabilities to create a system that is potent and verging on the cusp of omnipotence. This development can be considered a step-change function that has altered the application of air power. Long-term surveillance that can be buttressed by near real-time kinetic response is now available to decision-makers through the employment of the UCAV system.

While the UCAV systems have clearly indicated the future possibilities, they continue to function with a 'human-in-the-loop', even though the human is not physically located within the body of the vehicle.[3] Even more important is the fact that the decision to launch a lethal weapon is always taken by a human being within the mission-control cycle.

Although technology exists to ensure fully autonomous operations, it has not been incorporated into systems that apply lethal force, for a variety of reasons such as ethics, morality and international law. Therefore, the UCAV system sits in a

half-way point between traditional strikes from inhabited platforms and the concept of complete autonomy in the weapon release function.

Operationally, UCAVs have already proven their efficacy repeatedly. However, their unrestricted employment as an instrument of military power remains a vexed topic. A number of unresolved issues and challenges continue to inhibit their use, even as UCAVs are being employed almost in a routine fashion in on-going conflicts in the Middle-East and South Asia. The first and perhaps the most contentious challenge is the legal status of the UCAV operators vis-à-vis the laws of armed conflict.

The complexity is increased because a number of UCAV operators are civilians who are dealt with in a different manner to uniformed soldiers within the purview of the law. The other issues that challenge the employment of UCAVs are resource related—the cost-benefit analysis of their use; asset requirement to ensure adequacy of availability and the cost escalation thereof; survivability in contested air spaces; and the cost escalation per unit system which make them anything but expendable. However, these are not show-stoppers and can be addressed at the politico-military level.

UCAV systems, with the assurance of having a human-in-the-loop in the decision-cycle, have proven to be effective in irregular wars where the air environment if benign. However, a basic question needs to be answered before these systems can be fully absorbed into the force structure to create a tangible step-change function. Will the conventional air forces of the world be fighting irregular wars in a benign or permissive air environment for the foreseeable future? If the answer is no, which seems to be the right answer, then the efficacy of UCAVs will have to re-evaluated in terms of cost-effectiveness and legal permissibility of the manner of their employment.

The developmental thrust of UCAVs will be influenced by the context of future wars, their characteristics and conduct. Currently, UCAVs have an ambiguous status, especially in smaller air forces, of a combat system that is 'good to have' rather than a 'must have' asset. Since there are moral and ethical 'doubts' associated with uninhabited systems, only a visionary approach to the concept of their employment will be able to balance their capability in relation to other air power systems.

Artificial intelligence and autonomy

The concept of autonomy in weapon release brings forward the question of the employment of AI in warfighting functions. In this article, the discussion will be restricted to the utilisation of AI in the application of air power. The employment of UCAVs has created a number of challenges to the military forces, mainly in the area of legal, moral and ethical considerations. Into this somewhat muddied atmosphere, the question of AI has been introduced.

Viewed in an unbiased manner, future concepts of operations and emerging employment opportunities that combine UCAVs and AI into a single system point towards a step-change function in the application of air power. However, both have to be considered individually before the practicalities of their combined employment can be studied.

Defining AI is considered an impossibility, since it is an absolutely nuanced entity and means different things in different circumstances. In a military air power context, AI could be generically explained as the 'intelligence' introduced into a 'robot'—the term robot denoting any machine capable of perambulation and conducting its own activities and regardless of the domain manner—to ensure that it functions in an autonomous manner with no human input for the full span of an independent mission. From a purely scientific feasibility point of view, autonomous operation is already a reality.

Even though autonomous capability has been repeatedly demonstrated, and AI has reached close to being a human-like capability in some contexts, the employment of a UCAV-AI combination for the application of lethal force brings out discernible challenges. These challenges are not technological but conceptual and mental. Irrespective of the challenges to the employment of AI, its introduction into the decision-making cycle is considered possible in the not too distant future.

The challenges to UCAV-AI becoming operational are mainly human in nature. The lack of trust in AI, exacerbated by the fear of a 'wrong' decision being made with disastrous consequences; the inherent human tendency to resist change; and the apprehension of not being in control, compounded by the inherent human need to maintain superiority over machines, individually and in combination, inhibit the unrestricted use of AI.

Stemming from the purely cognitive human element of trust, there is also a clearly visible political unwillingness to give complete freedom of operation to fully automated combat vehicles. This reluctance is particularly visible when the mission involves engaging an adversary with the application of lethal force at the discretion of the machine-AI combination. For some inexplicable reason, this reluctance is reinforced when the combination is part of air power.

In some respects, the fear of collateral damage from a UCAV-AI combination could be at the source of this hesitancy to give full autonomy to AI-controlled UCAVs. Considering the challenges, mostly originating in human reluctance to trust, it would seem that fully autonomous application of lethal air power is still a faraway dream. However, technical capability exists to achieve this step-change function.

It is difficult to predict the timeframe within which the UCAV-AI combination will find its niche in air power. With its maturation, air power will transcend another invisible step in being the power projection capability of choice. There is no doubt that an AI-capable UCAV, able to make weapon release decisions without a human-in-the-loop, will be fielded at the operational and tactical levels of war sooner rather than later. The acceptance of such a situation will be incremental and will start in the not too distant future.

The impact of artificial intelligence on air power

When the political and military strategic leadership accept the efficacy and the necessity of permitting the UCAV-AI system operate in a fully autonomous mode, there will be visible and long-lasting changes in the force structure of the air force, in the conduct and characteristics of war, and a necessary revision of the concepts of operations to achieve strategic objectives.

However, a number of questions will need to be answered satisfactorily before the UCAV-AI system can be made fully operational. Is there a role for humans in this system while the mission is in progress? Should there be a built-in monitoring system that has a human-in-the-loop to exercise a 'veto' if necessary? And, if so, can the system be considered truly autonomous? These questions are at the conceptual level of what constitutes autonomy.

If the issues of autonomy are overcome, the real impact of AI on the development and application of air power will become apparent through answering a series of questions. How will an autonomous system affect the philosophical level doctrine and the strategy of air power? Will the changes to strategy manifest as necessary changes to force structure and capability development? What changes will have to be incorporated in the ability of a force to generate and sustain air power? The answers to these questions will lead to more challenges and issues that will have to ameliorated before autonomous systems will be able to deliver on its promise.

Air power is poised to plunge into a great unknown. The situation is reminiscent of the time between 1918 and 1935, when a large number of theories regarding air power were developed, based on conjecture and buttressed by some wishful thinking. Such flights of fancy were unavoidable, since there was no explicit experience to base the development of theories and concepts. Today, there is no background experience to base the concepts regarding the employment of the UCAV-AI system. The maturing of the system's operational capability will mean charting a course into the unknown.

Artificial intelligence and focal points

The foundations of a force that generates and employs air power, more often than not an air force, is encompassed in four focal points—concepts for its employment; capabilities to operationalise the concepts; an organisation that provides the framework for employing the force; and people who make it possible. Any change

in the strategic framework of the force, irrespective of the reason for making that change, will also alter the relative balance between the focal points. It is critical to ensure that all changes to the equilibrium of the four focal points are carried out in such way as to retain the flexibility and efficiency of the force.

Air power delivered by a combination of machine and AI is the future. It is the step-change function that will elevate air power to the next level of competence. However, unlike the many evolutionary changes that have influenced the improvements in the application of air power, this step-change will involve a major resetting of the four focal points of an air force.

The unhindered acceptance of AI and autonomous mission-capable aerial vehicles will bring about a quantum change in the generation and application of air power at the strategic level. Changes at the strategic level to the focal points will obviously have a cascading effect on the conduct of an air campaign. On the other hand, at the operational level, the major roles of air power are unlikely to change, although they will be conducted with much lesser ambiguity and in a more responsive manner. The tactical level actions will remain almost the same but will once again be more responsive in the creation of the necessary effects.

The impact of unrestricted use of AI and the ensuing autonomous systems will manifest on the concept of operations and the four cardinal roles of air power. The necessity to have control of the air for autonomous systems to operate will pose a challenge to the UCAV-AI system. Their utility in the air superiority campaign and employment in a dedicated air combat role will change the manner in which control of the air is obtained.

In the extremely complex mission profiles that constitute an air superiority campaign, autonomous systems will need to be integrated minutely into the overall picture. This will require a complete overhaul of the existing command and control capabilities. In turn, the command and control infrastructure will have to be revamped to include far-reaching changes from the strategic to the tactical levels. Only after these changes have been instituted should the concept of operations be altered.

Similarly, the concept of strike will also undergo a transition with UCAV-AI systems becoming operational. There can be a 'launch-and-forget' capability that will stay airborne till the objectives are met, and also systems that can be kept in 'hiding' for long durations to track and then neutralise the target at the opportune time. However, this capability would yield better results when employed in irregular wars rather than in conventional high-intensity conflicts.

The more intriguing concept is that of a gradual shift towards an inhabited 'mother ship' controlling a number of semi-autonomous vehicles in all the major roles of air power. The changes will start to be effected at the lowest tactical level and only move to the strategic level at a very slow pace.

The concepts of operations will obviously have to adapt to an altered command and control system that will be unable to exercise the 'veto' option after a mission has been launched. This situation will have far-reaching significance and consequences, since the decision-cycle will be automated, and in a sense irretrievable, after mission launch. Since the concepts will have to be altered, it will automatically impinge on the capability development cycle.

The current cycle is long drawn. It is also cumbersome for nations that do not have indigenous industrial capability to produce air power systems. While the induction of AI and autonomous systems will also suffer from the same drawback, the manner in which information technology is evolving gives hope that the availability of AI and autonomy will not be as difficult as the more sophisticated earlier generation air power technology.

Capability development to support the concepts of operations will invariable lead to the need to analyse and alter the force structure. An air force of calibre should at all times be going through the process of force structure review to fine-tune and adjust the existing structure. This will depend on the organisation of the force, which provides the framework for the generation of air power of the required calibre and quantity.

An air force with a rigid organisation will find it difficult to create the necessary agility to identify, accept and apply AI and operationalise the

concepts of autonomous operations. Air forces are known for their flexibility, which must not be confined to operational and tactical levels of functioning but must be anchored at the strategic level of conceptual evolution of capability and command and control.

The key to force-wide flexibility is the people who continue to be the critical link in a chain that can be as long or as short as required, depending on the context of the application of air power. This factor itself is the flexibility of air power, in a strategically holistic manner. Air forces will have to take a broom to the current or traditional processes of selection, training and employment of their personnel. The ethos of an air force is influenced by the past.

All fighting forces glorify their past and base the present and future, to a certain extent, on the achievements of the past. With the step-change that AI and autonomy brings to the force, there has to be a clean and visible break from the past. This is not to suggest that the past is to be forgotten but that the new paradigm of the employment of air power surpasses anything that has been done in the past. At least in this case, the past is incapable of pointing the way forward correctly. A new horizon is looming and it will be failing force that does not understand this reality.

AI and entrenched autonomy in mission control will change concepts, capabilities, organisation and the people of the air force. Failure to make the necessary changes, failure to adopt to the emerging future, and failure to jettison the baggage of the past, individually and collectively, will lead to the failure of the force.

Conclusion

It is good to be able to state that air power is at the dawn of yet another glorious era. It is also good to be able to analyse and ponder the changes that today seem to be merely visible at the far away horizon, for this provides an opportunity to fathom the far-reaching consequences that come with step-change functions in the application of air power. Air forces, the primary generators of air power, are on the cusp of such a momentous change.

The technology-dependence of air power will continue to increase. The corollary is that technology will also become more resource intensive. The situation will require nations, and air forces, to maintain a balance between resource availability, allocation and the capabilities necessary to generate air power. The progress of air power through the acceptance of a step-change function, brought about by the combination of UCAVs and AI, may not be an assured possibility for a number of air forces.

However, that is the way of the future, there is no denying it. Not accepting the writing on the wall will only lead to abject failure of an air force when called upon by the nation to deliver security—an unacceptable state of affairs.

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Notes

1 Frederick L. Frostic, 'The New Calculus: the future of air power in light of its growing qualitative edge', in Richard P. Hallion (ed.), *Air Power confronts an unstable world*, Brassey's: London, 1997, p. 203.

2 David A. Deptula, 'The future of air power', in John Andreass Olson (ed.), *Global Air Power*, Potomac Books: Washington DC, 2011, p. 411.

3 Sanu Kainikara, *The Cassandra Effect*, Vij Books: New Delhi, 2016, p. 58.