ROYAL AUSTRALIAN AIR FORCE
AIR POWER DEVELOPMENT CENTRE

Working Paper
45

Artificial Intelligence and the Future of Air Power

by Sanu Kainikara

An abridged version of this paper was presented at the Air Power Seminar held in March 2018 at the Defence Services College, Wellington, The Nilgiris, India.

FOREWORD

One of the greatest global challenges facing a stable rules based order is the unprecedented and accelerating technology revolution, in particular how it will affect the fragile institutions within states. This technology revolution, through the emerging use of artificial intelligence, is rapidly changing the way that states can and will employ air power to project their national power.

While automation and machine learning threatens other aspects of human endeavour, de-skilling human operators and reducing the number and nature of jobs available, air power is likely to be an early and rapid adopter of artificial intelligence because it will allow quicker and safer decisions to be made.

Professor Kainikara has taken a unique approach using a technology acceptance curve to explain how rapidly artificial intelligence is changing air power technology. He also describes the human side, which has potential to limit the acceptance of artificial intelligent systems. He then outlines a future model of air power where these intelligent system have been adopted and proposes how the joint domain will be changed.

This Working Paper, while focusing on artificial intelligence, does not omit the human condition—an essential element of air power. It outlines a case where artificial intelligence is inevitable and how we might need to adapt our own thinking to keep a competitive edge. I hope that the concepts outlined by Professor Kainikara will generate debate and encourage other authors to share their own research and ideas.

GPCAPT Andrew Gilbert
DAPDC
May 2019

INTRODUCTION

Artificial Intelligence (AI) is one of the latest technological marvels to have taken the fancy of futurists, strategists and technologists, and also captivated the world. It is also possibly the one with the greatest capacity to create change and cause disruption to the smooth and normal functioning of the world. Over the past few years, research breakthroughs and associated policy conversations have alerted and altered the public consciousness regarding the potential risks and benefits of AI. The discussions regarding AI—what it means, how it will affect human societies, and the consequences of keeping up with the on-going developments as well as not keeping up with them—are issues that have agitated the minds of people across the world.

It is now certain that no human enterprise—warfare, healthcare, economy, art, education and myriad others—will be immune to the encroachment of AI. As and when AI is fully incorporated into the working of a society, the very roles of humans in that society as we currently understand it, will change irrevocably. AI has been operationalised but its maturity is at the basic level of the beginning of a long journey. With maturity, its impact on society will also increase manifold.

It is an old cliché that air power was born of and nurtured by technology, but it still holds as true today as it was at the birth of air power as the third element in traditional military power projection capabilities. Therefore, it is not surprising that AI, the latest technological development, will impinge on the generation, sustainment and application of air power. The implications of the impact of AI on air power will perhaps be more significant than what can be conceived now. It will influence the breadth and depth of air power and alter the prevailing concepts regarding its conceptualisation, development and delivery.

Under these circumstances, in the future air power will be applied in significantly different ways than how it has been done in the past and how it is being done at present. However, predicting the future is not an accurate science even if adequate information is available. The maximum 'throw-forward' in predictive forays that can be considered viable is only 20 years. Even though a 20-year window is a short span of time, a reasonably good effort can be made to look at the future by tracking the forward march from where air power has come from and where it is at today, and then extrapolating it to the future.

This paper will examine the impact of AI on the future employment of air power under five very broad groupings that will make it easier to understand the interaction of AI with air power and clearly delineate its impact on future air power application. They are:

1. the major enduring aspects in the application of air power in order to fix a datum line from which it will become easier to discern the current status of air power and draw a line from where this point has been reached;

2. the intricacies of understanding the relationship between time and complexity of technology vis-à-vis the exponential technology acceptance curve in the generation of air power;

3. an understanding of AI as it pertains to military usage, with special reference to air power;

4. superimposition of AI onto air power as it is recognised today in order to make a few educated guesses regarding the uncertain futures that are being generated; and

5. an examination of how the induction of AI into an air force will affect the focal points of the force.

ENDURING ASPECTS

Air power has been an instrument of war for a little over a century. In this developmental journey of a century, it has greatly enhanced its capacity to create the necessary effects through the application of lethal force, on one end of the spectrum, to the delivery of humanitarian aid and disaster relief during calamities, at the other. The instances of the employment of air power in different events are numerically very large. Each such episode has contributed to the refinement of the techniques of employment, created opportunities to develop improved concepts of operations, and broadened strategic air power thinking. In modern times, after the end of World War II, there have been unambiguous moments in the application of air power that have had durable effects on the development and concepts of air power, mostly at the operational level. However, in the strategic arena, Operation Desert Storm in 1991, stands out as a watershed moment in the employment of air power.

Operation Desert Storm demonstrated the great strides that air power had made in enhancing its effectiveness. More importantly, it demonstrated the agility with which air power's command and control structure could be integrated with broader campaign plans. Air power also validated its claim of being an element of military power that could create joint effects with minimal effort, but with rapidity, precision, proportionality and discrimination. While air power has had its watershed moments during its century of development, 1991 was the year when the promises made by air power theorists of the early years were delivered in full with the perceived limitations of air power as a combat element being removed and air power becoming vindicated.

From that unmatched demonstration of its capabilities, air power has rapidly improved its capacity for delivering the necessary lethal force with precision, proportion and discrimination, while minimising both collateral damage and risk to own and friendly forces. The qualitative edge of air power has been enhanced in a process that could be termed an evolutionary revolution. While the decade that followed 1991 entrenched the enduring aspects at the root of air power as the basis for its application, it also had significant implications for its future.

A fundamental question emerges from the developments of the recent past – what is and will continue to be enduring in the application of air power? In other words, what aspects have not changed in the employment of air power over the past century of its existence as an instrument of military power, which are likely to persist into the foreseeable future?

The answer is two-pronged. First, the best practices in the application of air power, from the first days of its employment as a military capability, have always been captured by the practitioners as doctrine. The philosophical level doctrine of capable air forces has always been sophisticated and been continually refined with new developments, either in the concepts of delivery or the technological innovations that improve air power capabilities. Second, the main enduring trend of air power is that the classic roles of air power will not change even as their delivery, in terms of methodology and concepts of operation, will continually evolve. This aspect is of great importance in understanding the role AI is bound to play in the foreseeable future of air power development and employment.

The four fundamental roles of air power are control of the air, strike, air mobility and intelligence, surveillance and reconnaissance (ISR). Control of the air continues to be a prerequisite for the success of all military operations. This was recognised almost simultaneously to air power becoming an influential element of military power, at the beginning of World War II. Airborne strike has now become accurate, proportionate and discriminate, facilitated by technology-enabled capabilities and weapon systems, as well as a systems approach to targeting. It has also become time-sensitive through the use of uninhabited combat aerial vehicles (UCAV) that can fly at very high altitudes and have long endurance, making it possible for it to remain 'hidden' from potential adversaries until the time the target has been identified and a strike can be carried out.

Air mobility has developed into a capability that is increasingly responsive and able to sustain large forces operating further away from home bases. The ability to transport personnel and materiel to the operational theatre and sustain them in the war zone has been enhanced with enhancements in the range, speed and carrying capacity of transport aircraft. Further, air mobility is critical to Special Forces operations. In a majority of cases, Special Forces are inserted, sustained and extracted by the use of air lift assets and they are provided

fire support by the strike elements of the air force. Airborne ISR envelopes the battlespace and facilitates information flow across the chain of command, domains and time.

These basics of air power are enduring. The trend in air power development since the mid-1990s has been to make these roles more effective through the innovative absorption of technology that in turn improves the responsiveness and efficiency of the decision-making process that delivers the appropriate effect. For example, the enhanced range of air-to-air weapons and increasing sensor ranges has resulted in an expansion of the diameter of the air superiority bubble that can be created. Similarly the improvements in response time and accuracy of strikes as well as the limited autonomy that has been granted to them makes air strikes a prized capability, capable of creating the necessary effects when they are employed, in the majority of cases. Air mobility has also been enhanced with much greater one-time load capability that is delivered faster. ISR has seen sensor horizons move farther away, become more discerning and also become space-based.

Essentially air power as an entity has become more responsive and accurate while being able to influence a much larger 'area' than ever before. It can protect more, see further, be more covert and reach out to touch more targets, faster.

THE PLATEAUING OF AIR POWER DEVELOPMENT

The improvements that have been brought about in the conduct of the enduring roles of air power have improved the efficacy of its application. However, the reality is that the technology-enabled evolution that air power has been undergoing for the past century has plateaued. Air power itself has now matured into an important and critical instrument of national power. There is no doubt that improvements in the application of air power and the methodology of the conduct of its core roles will continue to improve. Targets will be struck with greater accuracy, response times for strikes will reduce and collateral damage will become miniscule. The cycle of finding, fixing, tracking and engaging a target—the ability of a system to perform a mission—will become combined in a single platform, with or without a human on board will become the norm rather than the exception. Such a system will increase the reliability and decrease the time for response. Such enhancements will continue, perhaps at a slower pace than before.

The rate of introduction and the assimilation of new technologies into air power employment, as well as the development of new concepts for their application has increased manyfold in the past few decades. The impetus for pursuing the development of new and innovative aviation-related technologies and the inordinately rapid rate of their induction could be the need to support a single operator carrying out increasingly complex multi-tasks in an air power context, as opposed to other military capabilities that are normally carried out by a group of people. From being technology-enabled air power has become technology-integrated.

There are three enduring factors that have become entrenched as determinants in the employment of air power, even as its vigorous development of the past century is plateauing. First, the strategic need for strategic power projection, which has become critical to ensuring national security, has become the realm of air power. Second, in the application of air power, precision has replaced mass. Third, at the operational level, air power has now matured to an extent that it can create the desired effect with extremely minimised collateral damage. All the three determinants are crucial to the design of air power for the prosecution of a conflict within the norms accepted by contemporary nation-states in the conduct of a modern war.

Currently air power is continuing to accept new technologies, but they only further entrench and enhance the enduring factors that have been described above. They do not create a quantum jump in air power capability.

The Technology Acceptance Curve (TAC)

The graph in Figure 1 plots relative time on the X-axis and the complexity of the technology to be accepted on the Y-axis. The Technology Acceptance Curve that has been plotted illustrates the exponential, rather than evolutionary, growth and development of technology in terms of the complexity and sophistication associated with it. On the TAC has been superimposed five technological innovations that have created, or will create, a step-change function in the century-old evolution and application of air power. Here, a step-change function is

described as a change that creates highly significant and extraordinary improvement in the efficacy of air power that stands outside a normal evolutionary curve.

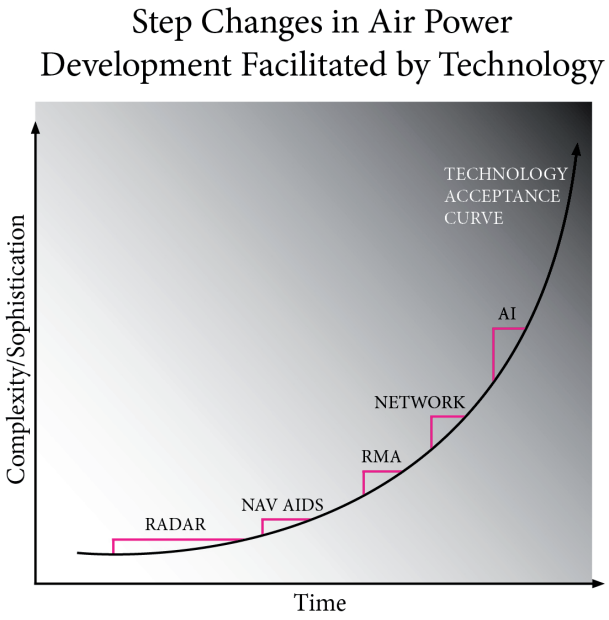

Figure 1. Technology Acceptance Curve

The first four of the five step-change functions have already taken place. The fifth, AI, is already on the horizon, even though its acceptance and operationalisation within the ambit of air power is still someway in the future. There are two factors that must be highlighted in Figure 1. First is that in the earlier step-change functions, such as Radar and Navigational Aids, the complexity increase of the technology was relatively small and the time available to accept the technology was comparatively long. Therefore, even though both of these developments were step-change functions, their absorption into air power was relatively easy to carry out—smaller capability jump and sufficient time to adjust to the changes. As the complexity and sophistication of technology being offered increase, such as for the Revolution in Military Affairs and Networking, the time available to accept the technology reduces primarily because the TAC develops an exponential change.

Two fundamental factors become apparent from the TAC. First, the complexity of technology to be absorbed is continually increasing; and second, the time available to accept and operationalise cutting-edge technology is continually decreasing. This process will continue till such times as it reaches a saturation point and no more efficiencies can be produced. It will rest at that point till such times as when another, as yet unknown, factor will create further efficiencies.

The TAC can be smoothed out to cater for the lethargies inherent within a force that also wants to accept the technological developments that are taking place. Smoothing the TAC, as shown in Figure 2 will create more time for the acceptance of the new technology. However, there is a fundamental challenge that comes with smoothing the TAC—the complexity graph will increase exponentially and catching up with the sophistication of technology will become extremely difficult and resource-intensive. In a worse-case scenario, the technology being absorbed will not be at the same level of complexity as what is made available to forces able to stay on the original TAC, creating an unbridgeable technology gap.

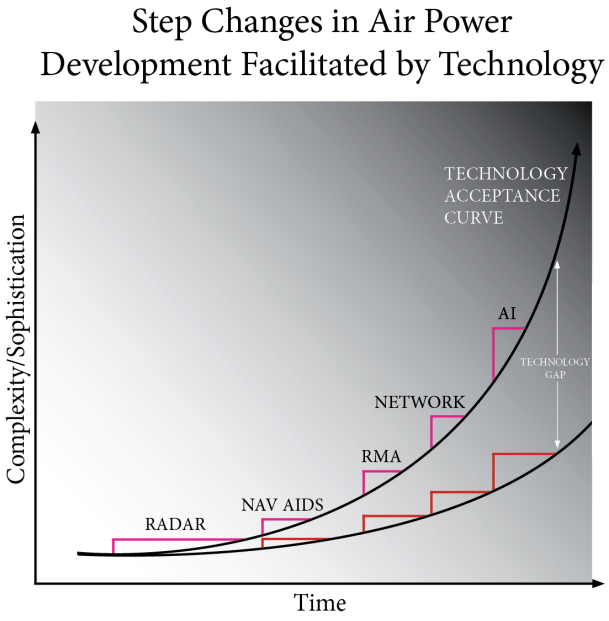

Figure 2. Smoothening the TAC

The Next Step-Change Function on the TAC

It can be stated with reasonable certainty that the next step-change function to impact air power development will be Artificial Intelligence (AI). In assessing this evolution, the semi-autonomous and intelligent Uninhabited Aerial Vehicles (UAVs) and their armed versions, Uninhabited Combat Aerial Vehicles (UCAVs), have been discounted as having created step-change functions. Their influence on the development and application of air power has been evolutionary rather than revolutionary. However, when UCAVs are combined efficiently with AI to create a 'system of systems', resident in the same platform, a step-change in air power capabilities will become tangibly visible. Such a system may not be fully autonomous and could have a human-out-of-the-loop to provide strategic governance.

ARTIFICIAL INTELLIGENCE

What is AI?

AI is being developed for use in almost all areas of human endeavour, including the military forces. Perhaps because of this wide spread of utilisation, defining AI is considered a difficult task. AI is far too nuanced to be placed under one generic definition and needs to be described in a contextual manner. This fact is further reinforced by the very broad spectrum of AI that start from a binary trip-switch to self-learning and truly intelligent machines. A broad and base level definition of AI could be, 'the ability of a machine to scan, analyse and translate information to achieve a desired outcome.'

This fundamental definition can then be altered to encompass the nuances of AI as it is used in different spheres. Building on the base definition, for the military the definition can be further distilled to read as, 'Intelligence introduced into a warfighting system, which provides that system with the ability to function to varying levels of autonomy and achieve a desired outcome without any human inputs for the full span of an independent mission.'

This is the definition that has been used for the discussions in this paper. Drawing a baseline is critical to understanding the future. To understand the future utilisation of AI requires a clear position statement regarding what is meant by AI.

This paper examines three aspects of importance regarding the influence of AI on air power:

1. The employment of AI in the application of air power;
2. The potential of AI to revolutionise the employment of air power; and
3. The impact of AI on the four focal points of an air force.

Challenges to the Employment of AI

The current methodology for the application of air power normally entails the employment of airborne systems. UCAVs are already in regular use, but functions with a 'human-in-the-loop', with the person is remotely located in a majority of cases. The most important factor about the employment of UCAVs is that the weapon release decision is always taken by a human being since it is still not politically acceptable for destructive power to be employed by AI in an autonomous mode. Further, there is also a governance requirement to ensure that weapons must only be employed in accordance with the Laws of Armed Conflict (LOAC). This could be better accomplished with a human in the decision-making cycle for weapon release. The UCAV System could be considered the half-way point in the continuum of air power development. It fits between traditional strikes by inhabited aerial platforms and the concept of complete autonomy for the system, including the weapon-release decision.

It is now technologically feasible to have complete autonomy for airborne systems to carry out an entire independent mission without having even a human-out-of-the-loop for governance purposes. Such systems have been conclusively demonstrated and are real. It can also be stated with more than adequate assurance that the introduction of AI into the human decision-making cycle will take place in the not too distant future. However, few challenges still remain that will impeded further progress in providing full autonomy to the systems that are operated by AI. These challenges would have to be overcome decisively to ensure further progress in the acceptance of AI-controlled systems.

These challenges are not technological, but sociological; derived from the cognitive domain of human beings. Four interconnected human factors inhibit absolute acceptance of AI and the transfer of complete autonomy to AI operated systems—**trust, inertia, understanding and empathy**. Trust – the reliance on the integrity of a person, or on some quality or attribute of a thing – is the biggest challenge that AI faces within in gaining acceptance within human thinking. There is an inherent and palpable mistrust of machines in the human mind, which takes a conscious effort to overcome. Inertia, both personal and organisational – the tendency to be inactive, resist change or continue to travel in a straight line – adds to this mistrust, further entrenching the tendency to resist change. Equally important is the lack of clear understanding of the intricate decision-making process of AI that in turn creates apprehension in delegating complete autonomy to an AI-operated system. The apprehension peaks when the delegation relates to the most critical phase of decision-making—that of weapon release. The fourth issue is empathy – the mental acceptance of the feeling or spirit of a person or thing – or the lack thereof. The inherent human need to be in control of machines, brought about through generations of human-machine interactions with the humans being in control, creates a lack of empathy. Further, lack empathy for AI is also caused because of its dissimilarity to human beings. This human tendency is also difficult to overcome and will perhaps take a certain amount of time to be accepted.

AI and Air Power – A Future Model

As AI starts to become more 'acceptable' within the decision-making cycle of airborne systems, it is necessary to examine the probable changes that could take place in the employment of air power in the future. In the immediate to near-term future, within about 15 years from the time AI is fully accepted into the 'observe, orient, decide, act' loop in the application of air power, the following four major changes are likely to take place.

Human-Machine Integration. First, air power will be delivered, across all its roles, through human-machine integrated mission packages. A human-machine integrated package would mean that some elements within the package would be AI-operated systems with autonomous liberty while some others will be systems, inhabited or otherwise, but with a 'human-in-the-loop'. The level of autonomy given to the AI-operated systems would vary with the numbers involved and also the level of acceptance of AI prevalent at that time. In a human-machine integrated package, there could also be a governance role for the inhabited systems, which could be tailored to meet mission specifications.

Target Recognition and Targeting. Second, will be the acceptance of autonomous target recognition, selection and engagement. The application of air power is controlled directly by the find, fix, track, target, engage and assess (F2T2EA) process. This engagement process to create the necessary effects will be AI controlled and therefore be a more rapid process, once sufficient autonomy is built into the process. The F2T2EA process will not only become an accelerated process but will also become more accurate, especially in the phases of engaging and assessing.

Airspace Management. Third, autonomous airspace management could be done through the employment of AI. Autonomous airspace management will facilitate a seamless interface of separate civil and military airspace as well as the control mechanisms. In this context, there is one element that needs further elucidation. In the airspace management regime, it is possible that in the near future, autonomous aerial vehicles will be controlled by autonomous airspace management agents. From a purely human understanding point of view, such a situation—of machines controlling machines without direct human oversight—may not be an acceptable state of affairs. Perhaps, at least for the present, this would be a 'bridge too far' in terms of the acceptance of, and trust in autonomy.

Combat Search and Rescue Operations. The fourth change, one that could be embraced as one of the earlier changes that could be facilitated by the induction of AI into operations is the benign role of CSR. The advantages of employing AI to conduct this critical role, especially in times of hostilities, is that own combatants are not placed at risk in attempting the rescue injured or other combatants in trouble. The employment would be somewhat like the SEAD missions that Uninhabited Aerial vehicles undertake on the first day of a campaign. Uninhabited AI controlled aerial vehicles could be the answer to complex CSR missions.

REVOLUTIONISING THE EMPLOYMENT OF AIR POWER

The employment of AI and autonomous systems in a normal day-to-day scenario is unlikely unless a number of pertinent questions have been answered fully. Truly autonomous operations will become a reality only if two fundamental questions can be answered in the negative: One, is there a role for humans in the system while a mission is in progress? Two, should a human be in the decision-making loop to exercise a veto function, which would amount to governance oversight in design and operations? If the answers to the above most fundamental questions is positive, then it is certain that these operations are not autonomous in the strictest sense of its definition.

Another challenge that slows the process of accepting autonomous operations is the reluctance of the political and military leadership to accept the efficacy of AI to conduct such operations. Only when the human reluctance to implicitly trust AI and a system of Uninhabited Combat Air Vehicle-AI is completely removed from the cognitive domain of strategic decision-makers will real autonomy be granted to these systems. When the UCAV-AI combined system is accepted as the normal way of conducting operations without any external human interference, then three basic aspects of warfighting will change—the conduct and characteristics of war; the philosophical level doctrine and strategy for the employment of air power; and at the operational level, the concepts of operations will have to be revised. These changes will, in turn, impinge on all other aspects of war and conflict.

Conduct and Characteristics of War. When autonomous systems fighting each other become the norm, the conduct and characteristics of war will obviously change. The first question that emanates is obviously whether or not the contest between two machines could be classified as 'war' in the conventional sense of the word. If war was to be fought only between two machines, then there would not be much urgency to create rules and

laws that govern its conduct; nor would there be a great deal of interest in studying its characteristics, other than in a purely technical sense. However, it is highly unlikely, at least in the near to mid-term future, that a war would be fought only between machines; a future war would invariably involve a combination of machines and humans. In such a situation, the conduct and characteristics of war would change dramatically, along with the need to review the extant rules and laws that govern the conduct of war. A number of issues will come to the fore. For example—would it be legal and/or ethical for a machine to kill a human being and for a human to destroy a machine? Would it be permissible for a machine to neutralise a human inhabited decision-making centre, if that has been identified as a centre of gravity? While it is not possible to predict the direction of the changes that will take place, the certainty is that the conduct and characteristics of war will change and become more complex.

Philosophical Doctrine and Strategy. Philosophical doctrine underpins all aspects of the employment of air power. Currently there is no air force that has factored in the attributes of AI into the development of its capstone doctrine. Although it is accepted, for the time being, that AI has not come of age, air forces of calibre need to start analysing and investigating the fundamental changes that have to be made in their doctrine to accommodate the altered capabilities that will come with the advent of AI. If such an initiative is delayed, air forces risk having to play doctrinal catch up in the long term. Changes to philosophical doctrine will also have cascading effects, necessitating immediate and long-term alteration of force structure, capability development processes and the conduct of the raise, train and sustain functions of a force.

Concepts of Operations. It is at the operational level that the induction of AI will create the maximum visible effect. The fundamentals of developing concepts of operations will remain the same: concepts for the employment of forces at the operational level must always be aligned with the inherent necessity to create strategic effects, which in turn must support the achievement of national objectives. As and when the employment of AI becomes an overt reality, it will form the nucleus of the concept and will greatly increase the complexity of operational level conceptual development. At the same time, on-going developments in AI will limit the timeframe within which a particular concept of operation would be viable before becoming redundant. Since the same situation would be applicable to a potential adversary, the uncertainties in the conduct of war will increase exponentially. Success in operations will obviously hinge on the force being extremely agile, both conceptually and physically.

Areas of Radical Change

Based on the assumption that autonomy will become a reality in the future, not too far away, and be a routine feature of air operations, four areas of air operations that will see radical changes can be identified. They are:

1. Air campaign planning: the limits of human creativity could be augmented to increase the options and speed of air campaign planning;

2. Air domain: with the advent of systems controlled by AI, the air battlespace could get fully dehumanised, devoid of any human physical presence;

3. Air power application: the application of air power will in the future be a contextually balanced combination of mass and precision; and

4. Domain boundaries: the boundaries that clearly define the physical domains will start to become blurred and over a period of time become indistinguishable from each other, which could lead to multi-domain operations becoming the norm.

The impact of AI will be felt in all aspects of air power—from its conceptualisation, generation, application and sustainment; and the influence will invariably straddle the full spread of activities from the strategic to the tactical. Since there are already sizeable air power components resident in both the land and maritime forces, it is not difficult to perceive that the application of air power will no longer be the sole realm of an air force. Although the physical demarcations between the domain-centric forces may have blurred, the warfighting domains are still clearly defined by the domain knowledge and professional mastery of the soldiers, sailors and

airmen. With the unlimited introduction of AI, the specialist knowledge required to employ systems will also have a common element to it, which in turn will further distort the clear definition of domain-centric mastery. The employment of AI will smudge the traditional divisions between the physical warfighting domains and blur the traditional divisions of responsibilities and liabilities.

Impact of AI

Air power has, in the past few decades, become a capability that has reached a point from which all further improvements will only be incremental in a contextual manner. Step-change functions that have added to the rapidity of air power development are unlikely in the current developmental situation. Air power delivered by a system that combines AI and machines is clearly the future. Even if complete autonomy remains a futuristic concept for some more time, there is a certain assurance that fully autonomous systems in the warfighting arena will become reality. This AI-machine combination functioning completely autonomously will be the next step-change function in the developmental history of air power. This will provide an exponential improvement in the application of air power that will elevate air power itself to the next level of competence. Since the improvements will emanate for the strategic level, it is not difficult to imagine the cascading effect the changes will have in the conduct of an air campaign and the tactical appreciation of operations.

One of the most important impact would be the difficulty in understanding the AI characteristics of the adversary. Although AI is 'machine' built, its development will also be directly influenced by all the elements that make understanding the broad warfighting ethos of a people, nation or armed force a difficult proposition. Understanding AI developed by a particular nation will be as complex as understanding that nation as an adversary. The culture, ethos, morality, ethics, and myriad other factors pertaining to the potential adversary would have to be studied to understand the AI developed by that adversary. Even after such analysis are done, there will always remain a certain percentage of unknown developments that have taken place. In the warfighting dimension, understanding AI is almost like understanding a human war fighter—it will be as complex and as unpredictable as human beings.

AI AND AIR FORCE FOCAL POINTS

The foundations of a military force that generates, applies and sustains air power—normally an air force—are based on four focal points; capability, concepts, organisation and people. These four focal points have to be maintained in a pre-set balance for the force to function at optimum efficiency; the balance being calculated taking into account a number of variables and their interaction with each other. Even minor changes to the strategic framework of the force will have cascading effects and definitely alter the relative, and fine, balance between the focal points. These changes to the balance and the arrival at new balancing points are necessary to ensure that the force retains its inherent flexibility and agility, and that it remains efficient.

Capability development has to be based on a realistic threat assessment and meeting the strategic needs of Government. There are four determinants that are fundamental to the success of the capability development process. One, the nation's ability to resource the necessary capabilities, through indigenous development or external acquisition; two, the veracity of the future strategic assessments to derive the threats to the nation and responses to them; three, the ability of the capability development process to integrate directly to the concept of operations and establish a cyclical relationship with it; and four, to be able to maintain a continuous and open-ended process that caters for the need to be flexible and agile when any of the three other fundamental determinants of capability development changes or is disrupted. The impact of AI on capability development will be indirect, felt through the necessary changes that will have to be made in the concepts of operations.

Innovative **concepts of operations** are hallmarks of professional air forces and maximises the effectiveness of available capabilities in achieving strategic objectives. This combination of sophisticated capabilities and innovative concepts of operations create the necessary and focused effects to achieving the strategic intent of the nation, through the application of cutting-edge air power. The unrestricted employment of AI will manifest in having to alter, recreate and further fine-tune the concepts of operations in order to take advantage of the enhanced freedom that would come with the removal of threat to friendly human beings. In turn, the conduct of the four core roles of air power—control of the air, strike, air mobility and ISR—would also be considerably

altered. At the fundamental level, air power will continue to carry out its roles, but the manner in which they are conducted will change radically. It can be envisaged that attrition tolerance will improve, especially when the systems being operated are relatively cheaper and more expendable since human lives would not be at stake.

The induction of AI and its influence on the development of concepts of operations would have far-reaching consequences. It would require a complete overhaul of the existing command and control (C2) structure, which is primarily based on the availability of a human being in the decision making loop, at least to provide a veto option if required. The C2 structure that would permit the unrestricted employment of AI will need to remove the human element from the operational and tactical level of functioning. Even at the strategic level, human input would necessarily be limited to giving the approval for a campaign to be conducted and then letting AI have full control of planning, execution, assessment and re-planning as necessary of the missions necessary to achieve strategic objectives. The absolute basic change in the whole process is that the 'human veto' function that has so far existed in all aspects of the application of air power—from the strategic to the tactical—will no longer exist.

At the apex of national security decision-making, the human element will need to still be in executive control. Therefore, the integration between the autonomous systems and the strategic decision-making cycle would have to be worked out minutely and precisely. Whether or not this integration is itself achieved through purely AI or a combination of AI-human element will depend on a number of extraneous factors and would vary from nation to nation.

The increased versatility that AI will potentially bring to the application of air power can only be fully exploited by an **organisation** that provides a flexible framework for its holistic employment. The framework should also be flexible enough to cater for the continual changes that will ensure the generation and sustainment of air power at the required level. Further, an agile organisation is a foundational requirement for the generation, application and sustainment of air power that is fundamentally oriented towards accepting and operationalising the concepts of operations to fully exploit the unrestricted usage of AI. The most important capacity that an agile organisational structure brings to the application of air power is the inherent flexibility that comes at the strategic level with it. Only organisations that are created with inherent flexibility will, in turn be able to create the necessary sub-structures with sufficient flexibility. The full-spectrum usage of AI can only be undertaken with an organisation that has agile and flexible structures at all levels. The requirement is for the organisation to be fully versatile from the strategic to the tactical level, while retaining the soundness of the structure.

People of calibre have always been, and will continue to be, the key to creating an effective air force to deliver air power. People are the key to force-wide flexibility and the critical link in the chain that keeps the cycle of generation, application and sustainment unbroken. This cyclical chain could be as long or as short as possible, depending on the context of the application that is being envisaged. The ability to extend or shorten the cycle is a factor of the overall flexibility inherent in air power and is also a function of the professionalism of the people involved.

All fighting forces are influenced by the events of the past and use them as building blocks to create and maintain the fighting spirit essential to win in future combat situations. To some extent glorification of the exploits of the past is also resorted to in order to sustain the fighting ethos of the force. These are people-oriented activities. However, with the introduction of AI-based autonomy into operations, the need to create esprit de corps among war fighters may diminish considerably. It will follow that the current selection process and the training and employment regime for airmen would become redundant. A combat force based on the autonomous employment of AI would need to develop a different process for the selection, training and employment of its personnel.

AI-based autonomy in mission control will bring a step change function and new paradigms to the employment of air power—across the spectrum of its application. In this context, the past, while it should not be forgotten, does not provide any tangible pointers to the future. The only assurance is that air power capabilities, concepts, organisation and the people who employ it will all evolve into something completely unlike what is normal today.

CONCLUSION

With the advent of AI a new horizon is looming in the firmament regarding the future of air power. Air power is about to plunge into a great unknown of both risks and opportunities. It will be a failing force that does not recognise this reality and/or take appropriate actions to ensure that the advantages are captured and the challenges addressed. The adage, 'first in will be best dressed' applies to the understanding and leveraging of AI. The development trajectory of air power has arrived at a situation reminiscent of an earlier time between 1918 and 1935, when large numbers of theories regarding its effective employment were developed and advocated. Most of these were based on conjuncture and often buttressed by some wishful thinking. The flights of fancy were unavoidable at that time because there was no explicit experience to act as the foundations for the development of theories, concepts and doctrine.

The introduction of AI will bring air power to a similar juncture—today there is no background experience to base developmental thinking, create theories and concepts of employment for an AI-based fully autonomous system. There is no option but to chart a course into the unknown, a course that should run parallel to the maturing of the autonomous systems' operational capabilities and their acceptance into the day-to-day functioning of a force. Failure to make the necessary critical changes to ameliorate the emerging challenges, failure to adapt to the ever-changing future, failure to jettison the baggage of the future, failure to accept the momentous changes already in train—individually as airmen and collectively as an air force, will lead to catastrophic failure of the force.

With the advent of AI, air forces—still the primary generators of air power—are on the cusp of an oncoming, and as yet unfathomable, but momentous step-change.

> 'In the early twenty-first century, the train of progress is again pulling out of the station – and this will probably be the last train ever to leave the station called Homo Sapiens. Those who miss this train will never get a second chance. In order to get a seat on it you need to understand twenty-first century technology, and in particular the powers of bio-technology and computer algorithms… those left behind will face extinction.'
>
> - Yuval Noah Harare,
> *Homo Deus: A Brief History of Tomorrow*, 2015