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CHALLENGES TO MODERN ROTARY-WING AIR POWER

'To the invading North Vietnamese, the AH-1G Cobra was a formidable adversary. Jets were too fast to be accurate but the Cobra could work its way inside a fight, stay there, and shoot it out with great success.'

Vietnam Air Warfare, Eds Robert F. Dorr & Chris Bishop, p. 179.

From its inception and subsequent operational induction, helicopters have become an integral part of battlefield air power. Even as 'vertical lift' capabilities became a crucial component of a holistic air power capability, they remained vulnerable to adversary action when operating in contested airspace. This was not considered a major inhibiting factor to the employment of rotary-wing airlift assets in combat zones, since the operating airspaces in the campaigns of the past few decades have been benign, which permitted helicopters to operate through the full extent of their operational spectrum without being unduly threatened.

RAF Mk4 Chinook inserts troops onto a mountain-top

However, two unrelated factors have gradually changed this paradigm. First, the introduction of sophisticated but relatively cheap and readily available air defence systems into the battlespace, even in irregular warfare campaigns, have necessitated a fresh look at the inherent capabilities of rotary-wing assets and also their *modus operandi* in combat zones. Second, the typical irregular war scenario has evolved over the past two decades, moving away from pure counter-insurgency operations towards a potential for high-end conflicts with peer or near-peer competitors. This is so because the airspace over contemporary conflict zones have become congested, divided and controlled by different entities with sufficient air-denial capabilities to enforce such control. Combat zone airspace has evolved into a more technologically challenging one, which was not the case even two decades ago.

Although the changes to the battlespace have been gradual, they have manifested in a clear understanding that legacy rotary-wing assets will no longer be able to provide the necessary capabilities that had earlier made them come very close to being a deterrent force in irregular war scenarios. They no longer have the reach, speed, agility, and/or lethality required to positively influence the outcome of a battle. More importantly, they do not have the level of assured survivability that would permit their uninhibited employment in a modern battlefield.

It is a paradox that while the employment envelope of helicopters has continually expanded, the development of their performance envelope has remained somewhat static because of technological constraints. Their operating environment makes them vulnerable to both the look-down shoot-down capabilities of fighter aircraft and small arms fire from the ground and/or surface-to-air missiles.

Helicopters now have several primary battlefield tasks—transport, attack, medical evacuation and Special Forces operational support. There is now renewed efforts being made to overcome the limitations of rotary wing assets so that their true potential can be realised. Concepts and technologies are being developed through innovative employment of cutting-edge developments in aerodynamics, flight controls, structures and materials through modelling and the use of analytical tools.

A great deal of research is being focused on the biggest technical challenge that faces helicopters—overcoming

the speed barrier, which is approximately 175 knots for a conventional rotary wing craft. The inability of a helicopter to push past this speed limit is caused by a phenomenon, generically termed 'dissymmetry of lift'. In order to understand this at a very basic level, it can be explained as being caused by the development of unequal lift in the advancing and retreating halves of the rotors, that create a spinning disc as the helicopter flies. Design engineers are still struggling with the challenge of increasing the speed of conventional helicopters, as fixing one issue aggravates another. Innovations to solve this fundamental challenge through design configurations and rotor-blade technologies are on-going.

Another area of interest for finding a solution to the speed barrier is engine technology, acknowledged as one of the most important factors for the design and development of future rotary wing capability. In this sphere a number of technological developments are also being attempted to enhance capabilities for helicopters—turbine engines are being trialled and electrical and hybrid propulsion systems are being studied. With the concerted efforts being made at improving its performance, the future helicopter is going to be faster and will also have greater range than the ones operating today. However, from a military operational perspective, enhanced survivability is perhaps the highest priority, which in turn requires combining a number of new technological developments. It will require not only enhancing the aircraft performance envelope in terms of speed and range, but also masking its acoustical, visual, infrared and electronic signatures.

Its distinctive noise has always been a defining element in helicopter operations. Acoustic signature reduction in all phases of the flight profile will reduce the advance warning of an approaching helicopter, thereby reducing the reaction time of the adversary and increasing the probability of survival. Visual, radar and electronic signature reduction is also being considered to improve the survivability of rotary wing assets. Although low observable or stealth technology has so far been limited to fixed wing fighter and bomber aircraft, helicopter power and propulsion systems are being designed to reduce both acoustic and infrared emissions and airframes are now being coated with radar-absorbent material. Reduction in the electronic footprint may not be of primary importance in irregular war situations, but assumes much greater significance in a peer or near-peer conflict and as adversaries develop and/or acquire more sophisticated electronic warfare capabilities.

Improving the performance envelope, especially in terms of speed and range, not only increases survivability but also the efficiency of helicopters in their critical roles of Special Forces operational support and casualty evacuation. In casualty evacuation situations, the faster a medical team can reach a casualty, better the chances of survival and recovery. Increased range will also influence the efficiency of helicopter medical evacuation since the aircraft would not have to land en-route in order to refuel, if the casualty is out of the range of a legacy helicopter. The advantage of increased range is that the helicopter itself could be based outside the reach of the adversary's weapon systems while still being able to carry out its mission with no apparent loss of time.

A challenge facing rotary wing operations that has not yet been effectively addressed is the question of their efficacy in functioning in a contested airspace against a peer or near-peer adversary. The answer may partly lie in modernising the rotary wing fleet to keep pace with the advances being made in hypersonics and artificial intelligence. There is no doubt that helicopters provide an unquestionable flexibility to battlefield operations and to surface forces in contact with the adversary through their ability to provide dedicated fire support and casualty evacuation. Their ability to insert, sustain and extract Special Forces elements with ease into contested areas acts as a force multiplier to a numerically-challenged force, which needs to contain a large geographical area. However, unless rapid improvements are made in their performance envelope and design features to mask their signatures—acoustic, infrared, electronic—incorporated, the general utility of helicopters and the flexibility they provide to surface operations would enter into a declining spiral.

Key Points

- *The introduction of sophisticated but relatively cheap and readily available air defence systems into the battlespace, even in irregular warfare campaigns, have necessitated a fresh look at the inherent capabilities of rotary-wing assets.*
- *Legacy rotary wing assets no longer have the reach, speed, agility, and/or lethality required to positively influence the outcome of a battle.*
- *Improving the performance envelope, especially in terms of speed and range, not only increases survivability but also the efficiency of helicopters in their critical roles of Special Forces operational support and casualty evacuation.*

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