

## SELF RELIANCE IN CRITICAL TECHNOLOGIES: USER PERSPECTIVE

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### Abstract

*Helicopters are useful in war and peace time operations and are suited for operating in vivid terrain. The helicopter fleet will continue to be an exceptional force multiplier that would primarily affect the entire range of accessible ground operations and is one of the most important assets available to a field commander in operations at tactical and operational level. The versatility of the rotary wing and its relevance in future war will primarily revolve around the employment of various technological advancement achieved along each passing year. Development of critical technologies to thwart the challenges emanating from the envisaged future military operations hold key for successful employment of these machines. The aim of evolving technologies in the domain of rotary wings is to facilitate higher degree of situational awareness while ensuring survivability in the fluid battle space. Another important aspect is to integrate and process information received from various sub system and ensure availability of the processed information as comprehensible and mission customized input to the aircrew. Army Aviation helicopters have graduated to undertake multi-faceted role and their application form integral part of Indian Army doctrine. The growth of Army Aviation is steadily filling the gap between desire and capabilities. Indigenization and self-reliance in the field of various critical technologies and concepts is the need of the hour as it is the only way forward towards exploitation of the rotorcraft to the best of its potential. Research and development in the field of technologies associated with rotary wing has become a necessity towards sustaining the relevance of these machines in the envisioned advanced operations*

### Introduction

Future warfare is going to be characterized by asymmetric operations, battlefield transparency and is bound to be network centric wherein the ever increasing reliance on technology requires no deliberation. The continuously altering dynamics of the battlefield necessitates unceasing prediction and evolution not only in doctrinal concepts, but also in application of technology. The application of various aspects of technological modernization will also vary from one state to another and whether or not the technological advancement achieved is indigenous or otherwise. This vital facet brings forth the inherent risk that various technological advancement bear, if outsourced or procured. Self-reliance being the only solution to thwart such threat, its necessity from programming space missions to manufacturing protective gears for soldiers cannot be overemphasized.

Helicopter by virtue of its versatility forms an important element of combat operation, support, rescue and sustenance. The significance of helicopter operations has been highlighted time and again commencing from Vietnam war to ongoing operations against ISIS in middle east. The relevance of these machines in the changing rules of engagement is attributable to the successful amalgamation of technological progression. Continuous upgradation and development of critical technologies has ensured effective employment of helicopters, in addition to enhanced safety and situational awareness.

The operational diversities of the Indian Army, coupled with variety of terrain, accelerated the acceptance of the concept of Army Aviation Corps as a lethal force-multiplier. Army Aviation has grown over the past few decades and has an inventory capable to perform combat support, induction and de-induction of troops, combat

search and rescue, medical evacuation, airborne command post, recce and surveillance etc. The rotary wing fleet in the Indian defence forces is poised for major modernization in the years to come. This involves upgradation in hardware, systems and procurement of new state of art equipment to enable them to meet the security challenges in the near future. Thus there exists tremendous opportunity for Indian civil industries to harness this market to develop indigenous capability.

### Envisaged Army Aviation Capabilities

The requirements as envisaged for helicopter operations in the future battle field are:

- The diversified application of helicopters in Army Aviation requires platform with capability to operate in different terrain, weather extremities, undertake day and night operations without any considerable decline in performance in either ends of the performance envelope.
- The capability to undertake multi-mission with small modification in configuration and equipment on the move.
- Modern attack helicopters to influence the outcome of operations in Tactical Battle Areas (TBA) with stand-off weapon capability during day and night.
- Multi spectrum EW capability, airborne command post and operational infrastructure for analysis of data and real time transmission to control the operations.
- Low radar and IR signature to avoid detection.
- Independent, jam proof, navigation capability with in-built redundancy.

### Critical Technologies

#### Avionics

Significant advances in technology in the field of avionics are a major driving factor for many of the helicopter modernization initiatives. Modern helicopter avionics technologies enhance situational awareness to increase safety and reduce common aviation accidents. The inherent elevated risk profile of a military aviator needs additional assistance from technology towards accomplishment of mission. If data in open sources are anything to be relied upon, our dependence for aircraft avionics on Israel [1] falls in the category of over reliance. Unpredictability of the dynamics of international polity and alignment and re-alignment of nations in the world

polarity does pose certain unanswered questions. Indigenous capabilities in the field of avionics such as mission computers, display processors etc have already been praiseworthy and all efforts should be made to ensure that we keep pace with the latest in this field. Few of these technological advancements desired in military helicopters are

- **Display Systems:** There is need to impart greater impetus to the development of display technologies such as optical thin films, thin TFTs, collimators for wide angle holographic HUDs, head/helmet mounted sighting systems and head level or head down displays. The future helicopters must incorporate smart electronic displays such as Multi-Functional Displays which can be easily reconfigured as the situation demands. It should be capable of overlaying and displaying a variety of data from a multitude of sensors with suitable clarity and resolution. In addition, the Mission Computers (MCs) and Digital Map Generators (DMGs), which will be a part of the entire package, must be capable of providing a 3-dimensional image of the terrain over flown along with the enemy radar orbit displayed, thereby facilitating independent fly through capability by the aircraft. These MCs must have reliability, Electro-Magnetic Pulse (EMP) proof redundancy incorporated (Dual) and capable of independent operation in the event of one MC failure. Also the MC must have adequate ROM and RAM to facilitate taking on tasks in unforeseen eventualities and multitasking.
- **Navigation Capability:** Helicopters need to have an independent, jam proof, reliable, redundant navigation capability with ability for feeding the mission from a portable data loader. Also it should be capable of uploading the mission directly from the ground via the data link. Also, these navigation systems must be coupled with recovery aids like VOR/ILS and TACAN for fixed and rotary wing aircraft to facilitate safe aircraft launch and recovery under adverse weather conditions.
- **Automatic Flight Control Systems (AFCS):** Presently the ALH have the AFCS for which we are dependent on multiple vendors for its subsystems. Therefore, we not only need the AFCS on all helicopters but also to have latest technologies like Fly-By-Wire/ Fly-By-Optics for flight control. These control systems must all be full authority, multi-redundant systems and battle hardy, enabling recovery even in the event of multiple channel failure.

- **All-Weather Capability:** Helicopters must possess latest night vision and all-weather capabilities. This translates into the helicopters possessing the necessary systems facilitating full mission operability with devices such as NVGs (Latest Gen) and IR systems like next generation FLIRs.
- **Data Link:** In the future battle, situational awareness is of paramount importance. Therein, the provision of rapid, near real-time data acquires critical importance. All airborne platforms thereby must have the facility for secure data linking for the real-time transfer of data between themselves and also with any ground-based agency.

There exists an urgent requirement towards self-development in the field of avionics to incorporate systems assisting the crew, ranging from mission planning to augmenting situational awareness in the modern battle field. The requirement becomes even more critical as it is the field of avionics that requires to be optimally exploited for minimizing the sensor to shooter link and facilitate effect based operation in time sensitive operations. The progress in this field associated with increasing dependence on the technology entails self-reliance to be attained in critical technologies related to use of avionics.

### Survivability

The requirements of modern battlefield entails development of technologies to enhance helicopter survivability including multi-spectral signature control, active/passive vulnerability reduction technologies, smart structures, defensive avionics and counter SAM capabilities, including missile and laser warning systems, expendables and passive and active countermeasures. The helicopter must be capable of surviving battle damage and there must be sufficient redundancy in all critical helicopter systems to facilitate positive recovery and, if possible, mission accomplishment even in the event of a dual system failure. Few of the necessities in future will be

- **Infrared Suppressor (IR):** In modern day warfare, it not only important to have stealth cover over the helicopter but also the need to shield the IR signature being generated by the hot engine of the helicopter.
- **Safety Systems:** Helicopter safety systems, akin to Traffic Collision Avoidance System (TCAS) and Enhanced Ground Proximity Warning Systems (EGPWS) must be incorporated, with the facility being available to the pilot to disable the system for any specific

mission. Also all helicopters would need to incorporate Reduced Vertical Separation Minima (RVSM) capability, as all helicopters operating above FL 150 need to be RVSM compliant.

- **Electronic Warfare (EW) Suite:** Presently the above system is under development to be fitted on ALH Mk-III and IV helicopters of Indian Army. The above system is again being imported and installed on the helicopter. We need to develop this system as the support in the event of war from vendors is doubtful. Therefore we need to indigenize these airborne sensors to detect hostile electronic emissions with improved noise and deceptive jamming capabilities. These sensors would need to incorporate better techniques, more power, improved reaction, increased performance in dense threat environments and broader spectrum coverage.
- **Missile and Laser Warning Systems:** It is essential for all helicopters to be integrated with MAWS (Missile Approach Warning Systems) and LWS (Laser Warning Systems). Coupled with the detection capability the possibility of incorporating a workable Directed Infrared Countermeasure (DIRCM) system must be considered.
- **Persistent Target Detection:** Develop technologies to detect, identify and track surface combatants in all-weather conditions, in both day and night operations, over long standoff ranges (beyond projected surface threat envelopes). The systems should have high probability of mission kill and low probability of collateral damage to support the engagement of surface combatants, landing craft, and other high value surface assets in the most challenging scenarios.
- **Mission Planning Systems:** These include graphic tools that allow the crew to optimally manage the tactical situation and accurately define the profile and feasibility of all types of mission [2]. The system will facilitate reduced reaction time and processing of information in real time enabling quick decision making.
- **Identification and Discrimination of Battle Field Targets:** Develop technologies to enable automatic detection and discrimination of small targets (eg. periscope) from all altitudes and/or standoff ranges and improve active/passive/multi-static identification algorithms to minimise false targets.

The survivability of a helicopter is a major facet which is directly related to the availability of trained crew. It may

be practical to procure/produce/repair a machine to facilitate its employment in a short period, however recycling of trained aircrew for usage during the short span may not be feasible. Hence the technological advancement in the field of survivability is likely to be of abundant prominence in case of hostilities.

### Engine Technology

Indian Armed Forces helicopters are totally dependent upon the foreign vendors for the turbo shaft engine technology to meet the wide requirement for helicopter operations varying from sea level to high altitude terrain. There is a gap between indigenous developments /capabilities and the capabilities of aeronautically advanced nations in this field. The industry must intensify its collaborative ventures to leapfrog and catch-up. We need to work out proactive strategies which need joint ventures between Private Sector and PSUs, as also need to fund research on above project in DRDOs and IIT Laboratories.

- **Engine Control Systems:** Present fleet of helicopters of Indian Army includes helicopters having engines with Full Authority Digital Engine Control (FADEC). It is the most important technology as far as helicopter is concerned where based on the flying requirement and aerodynamic factors, the engine control system controls the functioning of engines. These systems should have dual channel redundancy with cross talk among FADECs along with backup manual control available all the times. This will facilitate more fuel-efficient and surge resistant engine operations.

### Stealth

Stealth helicopters use various methods to avoid detection. Although rotary wing aircrafts are in many ways less suitable for stealth technology as compared to fixed wing aircrafts, however the requirement of clandestine operations wherein helicopters can play a pivotal role demands exploitation of this facet of technological expansion. The successful raid and elimination of Osama bin Laden [3] in May 2011 proved to be an apropos illustration of significance of stealth technology. This achievement when superimposed with the characteristics of future war, goes on to highlight the relevance of stealth technology not only for enhancing the success probability of any clandestine/surgical operations but also the survivability of heli-

copters in the tactical battle area. The aspect of stealth technology is definitely on its nascent stage and has found slight acceptance as far as research in India is concerned. HAL's Light Combat helicopter is reported to feature a digital camouflage system [4]. The use of advanced composite materials on the airframe has commonly resulted in reductions in an aircraft's radar cross-section. It can be easily predicted that stealth technology will be instrumental in dictating viability and extend of combat support extended to ground operations in the future engagements. However, the scope of stealth in context of its significance is yet to be realized and explored in India. The conversion of the present requirement of stealth helicopters will soon change into necessity in future and will inadvertently result in resorting to procurements from other countries.

### Aircraft Design

Heterogeneity in helicopter demand [5] is a topic well researched and brings to the fore an all important issue of modular design as a feasible solution. The concept revolves around utilization of different role specific modules to be mounted to configure helicopter in an envisaged role. The helicopters with modular modification functions as a partially autonomous aircraft with a modular build system allowing one main frame to serve many different purposes, decreasing the number of specialized aircraft needed. This system also reduces costs for the consumer by reducing maintenance downtime because of the ability to easily swap out modules allowing the aircraft to continue flying while mechanics repair the broken part. These modular aircraft will be well suited for humanitarian missions in difficult terrains and inaccessible areas around the country, response to natural disasters and assistance in war zones [6]. The advantages accruing out of this concept will also aid in optimum utilisation of a platform and towards cost saving by restricting the number and types of rotary wing aircrafts in inventory to support field formations.

Modern helicopters require strong structures capable of withstanding high aerodynamic loads but low in weight. The knowledge gained with indigenous development programme of Dhruv should be extensively utilised to build upon the composites being developed. There also exist a need to employ the latest techniques like advanced Computational Flow Dynamics tools in the field of Finite Element Analysis (FEA) and wind tunnel testing of the structural optimization is required.

### **Tilt Rotor Concept**

The concept exploits utilisation of vertical take-off and landing ability of helicopters alongwith high forward speed, higher altitude ceiling and carriage capacity of propeller aircrafts. The prototype V-22 Osprey is presently completely operational and has proved its worth as platform for fast induction and de-induction of troops/logistics over long distances and unprepared areas [7]. The assortment of best of the capabilities of fixed and rotary wing provided by this concept has already substantiated itself in the middle-east region and will prove to be of greater significance in the futuristic warfare. It becomes prudent that research and development towards customizing this concept to meet our requirement be undertaken. The platform enhances the military capability in terms of reduction in time by transporting increased mass over intended site. The concept is also advantageous for operations of Air Force wherein inter command move of logistics or troops is concerned, thus facilitating towards jointness in inter service cooperation in operations.

### **Weapon and Ammunition**

The recognized lethality of rotary wing platform against armor and ground forces has resulted in modern weapon systems with capabilities of engaging targets over ranges in excess of 8000 meters and various war heads to enable penetrating densest of the armor plates. The homing and guidance system varying from 1<sup>st</sup> generation heat seeking to 3<sup>rd</sup> generation fire and forget is another evolving field. The availability of AH-1Z Viper Attack helicopters with AGM-114R Hellfire II Missiles [8] with our western adversary further manifests this ever-growing threat. Development of fire and forget missiles with millimeter wave radar seeker coupled with inertial guidance possessing homing capability in adverse weather and in the presence of battlefield obscurants is the area that India needs to progress its present expertise on. The availability of indigenous weapons and ammunition will assist in assertive and effective utilisation of the weapon platform.

### **Noise Reduction**

Helicopter noise predominantly emanates from rotors, engine and anti-torque mechanism installed. The generation of noise adds towards crew fatigue and heightens the vulnerability of helicopters in a hostile environment due to ease of identification. Also, one of the factors detrimental towards stealth is the helicopter noise. Low noise

design capabilities are inherently impacted by technological feasibility and economic considerations [9]. Considerable research and activities focused on the exploration of active and passive rotor technologies, in addition to engine noise reduction concepts have been undertaken in Western countries. Although efforts are being undertaken towards noise reduction in the indigenously built helicopters as well, however the scope needs to be broadened. The reduction of noise will enhance the crew attention span with capability to operate with greater efficiency for longer durations. Thus noise reduction proves to be an intangible factor which will have greater significance during the course of actual operations and thereby qualifies to be an aspect of due consideration as far as indigenous research and development in the area is concerned.

### **Blade Manufacturing**

Rotary wing aircrafts being the machine which generally defy the logic of physics and aerodynamic, the evolution of rotors is one of the most important factor contributing towards enhanced maneuverability and speed of the helicopter. Although the development in rotor blades is believed to have reached stagnation, however research for achieving a better performance rotor continues. High lift production, use of composite material, delaying the stall and noise reduction are some of the area of rotor manufacturing [10] that is constantly evolving. The need to achieve ingenuity in rotor design is of utmost significance from aerodynamic consideration. The helicopter industry in India needs to take the next leap forward in this direction from present status of utilisation of composites to designing of blade concept.

### **Conclusion**

Future wars are going to be short, swift and network centric wherein helicopter fleet will act as one of the force multipliers for commanders at tactical and operational level. Exploiting the vertical dimension through modern helicopters with latest technology will be one of the keys to success. The indigenization of various critical technologies associated with helicopters is bound to maximize the operational potential of these platforms. Although joint ventures and collaborations caters for the immediate requirements and facilitate towards self reliance, the relevance of self-reliance towards these critical technologies cannot be overemphasized. The cause of concern remains the research and development capability of India as a nation which requires prompt initiation of corrective

measure, if we need to achieve the objective of selfreliance anytime in near future.

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