
Project Management Lessons from Aerospace and Defence Industry to lead in a VUCA World

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ABSTRACT

Aerospace manufacturing is a high technology intensive industry that produces "aircraft, space vehicles, aircraft engines, helicopters, propulsion units, and related parts". It is characterized by a long project life cycle encompassing R&D, engineering design, prototyping, manufacturing, assembly, maintenance, repair and overhaul. Intensive technology and safety requirements necessitate major investments in R&D, risk management, life-cycle management and quality control [4]. It also necessitates the need for effective supply chain management with early stakeholder engagement and trained manpower in order to unlock the burgeoning potential of this fast-growing sector.

The Indian aerospace industry is poised to grow rapidly and is currently one of the fastest-growing aerospace markets in the world due to an increase in defence spending, growing commercial aviation market, rising technological expertise and high levels of technical expertise and knowledge. DPE (Department of Public Enterprises) guidelines and Defense Procurement Procedure-2013 has changed the aerospace environment. The defence sector is more open to private participation on level playing field. That today's "world is flat" is mostly due to this changing business scenario. Encouraged by the offset policy and various defense programs in the pipeline, aerospace and defence majors world over and the local private sector players have begun to make a foray into this growing field of aerospace, establishing ventures for a share in this market. As this is a technology-intensive industry, requirement of technological skills and adapting to changes in technologies is a pre-requisite for the smooth functioning of any organization. Also, the customers' demands have become dynamic with the need to adopt measures like early stakeholder management, concurrent engineering, change management, knowledge management and talent management. Hindustan Aeronautics Limited, a pioneer in the aerospace domain in India, established in 1940, is a significant player in the aerospace market. In order to compete in this globally competitive market and make a mark, restructuring operations, diversifying and exploring new strategies is the need of the hour.

However, with the changing economic scenario, the role of Aerospace companies, especially PSUs in this domain, has undergone a radical shift. Along with being harbingers of technology infusion into the country, PSUs in aerospace industry like HAL and BEL also play a role in developing the manufacturing ecosystem in advanced technologies. This paper explores the changing roles and strategies adopted by Hindustan Aeronautics Limited (HAL) in acting as catalyst of technology growth and 'creating a sustainable supply chain' powered by a Project management approach for leading in this ever changing economic ecosystem and in the process contributing to nation building, technology self-reliance, employment generation, thereby enabling robust and sustainable economic growth of the country.

KEY WORDS — Defence Public sector undertaking DPSU, VUCA, Technology infusion, Supply chain Capability enhancement, Technology leadership, Project management approach, Make in India.

INTENT

The paper elaborates on the challenges posed by the changing world, ways to ensure robustness of business growth through technology development, project management lessons and strategies followed by Hindustan Aeronautics Limited (HAL) to lead the change and adapt them to the changing business environment in the aerospace domain. Strategies to counter economic unpredictability (VUCA), exploring new avenues for collaboration and business diversification as the defining means of leading in this VUCA world have been dwelled upon.

I INTRODUCTION

The Indian aerospace industry is one of the fastest-growing aerospace markets in the world. The PricewaterhouseCoopers report entitled Changing Dynamics—India’s Aerospace Industry indicates that the rapid growth of this industry has attracted major global aerospace companies to India and has incentivized domestic aerospace players to increase and deepen operations. All segments in the aerospace industry, including civil and defence aviation and space, are showing a significant level of growth, civil aviation, defence aviation and Space research [1] [2].

However, the last decade has seen a drastic change, in what was a stable and growing economic and business environment across the globe, in general and the Indian core Industry segment, in particular. Sudden changes in the technological environment, globalisation of the economy and increased frequency of black swan events [15] has increased the volatility and uncertainty in the environment leading to a ‘VUCA’ world – the one that is Volatile, Uncertain, Complex and Ambiguous. Ability to be responsive to the changes with agility coupled with a consolidation of capabilities to influence the environment is the key requirement to sustain in the industry. [7] In this journey, the way HAL has restructured itself to redefine its role with respect to its contribution to the economy has been explored. [19]

II STRENGTHS OF THE INDIAN AEROSPACE INDUSTRY

Aerospace manufacturing has traditionally not been able to mature as a stronghold in India. However, the Indian Aerospace ecosystem is witnessing a paradigm shift owing to the recent changes in Defence Procurement Policy that has opened up the defense market in India bringing in competition. The evolution of aerospace industry is expressed in Fig 1. Encouraged by the offset policy and various defense programs in the pipeline, global and local private sector players have begun to make a foray into this growing field of aerospace. Traditionally, PSUs like HAL and BEL have been the leaders in this sector. Some of the private entrants in this sector include Dynamics Aerospace, Taneja Aerospace & Aviation Limited (TAAL) and Tata Advanced Systems Ltd (TASL). Dynamics Aerospace has one of the largest infrastructure in the Indian private sector for manufacture of exacting Air Frame Structures and Precision Aerospace Components. TAAL manufactures small civilian aircraft, aero-structures and aircraft parts, provides aircraft maintenance services and represents Cessna Aircraft Company, USA, for the sale of its aircraft in India. TASL has launched the first Sikorsky S-92 Helicopter Cabin made in India at its facility at the aerospace and precision engineering special economic zone on the outskirts of Hyderabad[5] [10].

A. Manufacturing Base:

India offers cost advantages and the cost savings could range between 15 to 25 percent in manufacturing, depending on the type of components. Indian industry today has the technological capabilities to undertake complex manufacturing required for the sector. [4][5]

B. Trained Manpower:

An important enabler for any successful industry is enriched manpower base. It becomes even more indispensable in Aerospace and Defence owing to its dependence on highly skilled human resources. With over 380 universities, 11,200 colleges and 1,500 research institutions, India has the second largest pool of scientists and engineers in the world. Every year, over 2.5 million graduates are added to the workforce, including 300,000 engineers and 150,000 IT professionals. India is ranked third globally, after USA and China, in terms of absolute number of students enrolled in higher education institutions at 11.2 million students. According to industry feedback, the research and training institutes in India are insufficient as compared to the number of students. The government needs to invest more into the sector for the development of professionals so as to leverage the potential of the human resources in an effective manner. [5] This human resource pool can give an advantage in this sector. [4]

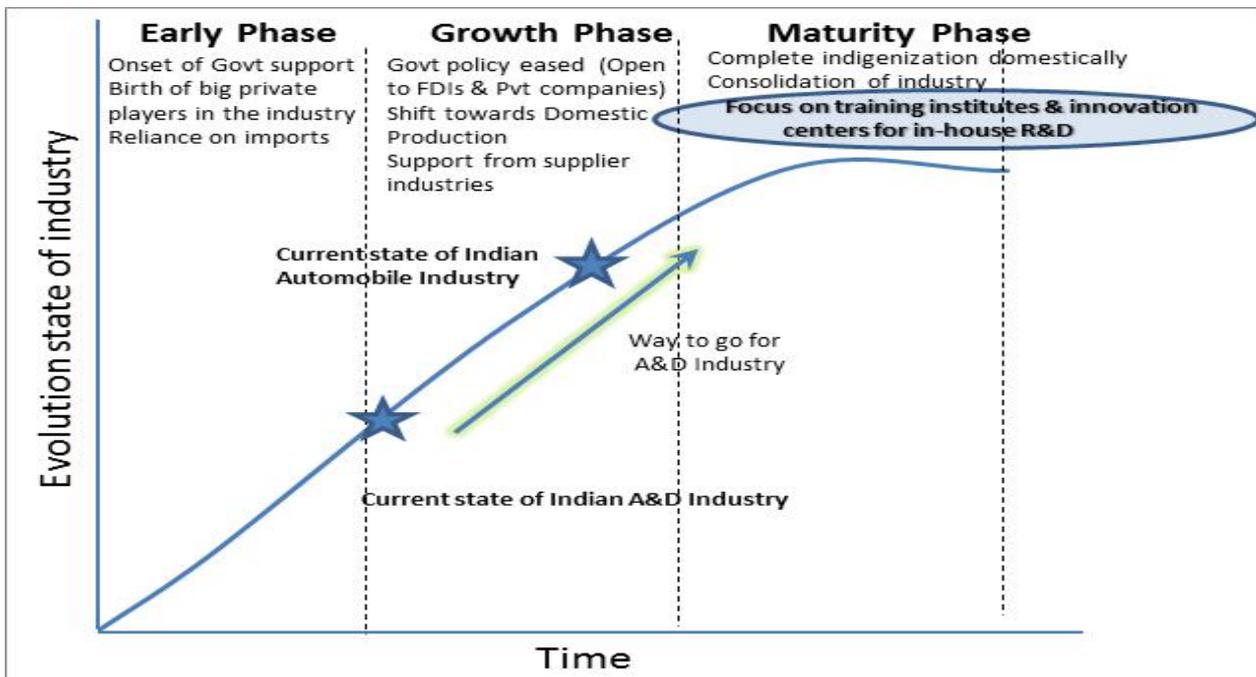


Fig1: Stages of evolution of aerospace industry - Source: Adapted from KPMG study [5]

III WEAKNESSES OF THE INDIAN AEROSPACE INDUSTRY

A. Lack of Collaborative Supply Chain

In recent times, aerospace industry has become more collaborative which allows to have shared objective still having individual targets. Outsourcing at Boeing for Dreamliner 787, ADS SC21 (The SC21 program is a key industry venture for Aerospace, Defense, Security and Space and is overseen, governed and managed by ADS on behalf of UK industry) are two important examples of collaborative supply chain. In India, such collaboration is yet to take place.

B. Gap In Technical Capability And Current R&D Situation

There exists a large gap in India's technical capability for catering to demands of indigenous production in Aerospace and Defence sector. Indian manufacturing needs to upgrade capabilities in precision engineering, micro engineering to take a big leap into the Aerospace and Defence sector. [5]. With regard to research in this sector, the R&D focus has remained largely in the public domain with government institutions like Hindustan Aeronautics Limited (HAL), National Aerospace Laboratories (NAL), Defence and Research & Development Organisation (DRDO), Indian Space Research Organisation (ISRO) and Council of Scientific and Industrial Research (CSIR). Some of the success examples of Indian R&D efforts in aerospace and defence is indigenous development of range of missiles (from short range to intercontinental ballistic) by DRDO, LCA (Light Combat Aircraft) and Dhruv-ALH (Advanced Light Helicopter) by HAL, and SARAS (multi-role aircraft) and HANSA (two-seater trainer turboprop aircraft) by NAL. Opening up of Ministry of Defence (MoD) funded, National Institute for Research & Development in Defence Shipbuilding (NIRDESH) is a positive step towards self-reliance by the government in this area. [5]

Indian software majors such as Mahindra Satyam, Wipro Technologies, Tata Consultancy Services (TCS) and HCL have been active in the aerospace industry for several years. IT applications have been developed for flight data management systems, power distribution inside the aircraft, software for crew signaling, cabin illumination and Global Positioning System (GPS), etc. We have also seen successful implementation of advanced technology by Indian private sector companies for producing global quality products and designs for the aviation sector. [5] The capability to leverage is present and so is a strong market, but the question that

remains to be answered is: are we doing enough to explore how technology could be developed and nurtured for Indian Aerospace and Defence?[12]

C. Poor Stakeholder Management

The onus for management of all stakeholders is not defined; hence there is no addressing of all the concerns of the stakeholders of the aerospace industry.

D. Less Synergy In Industry-Academia

The Working Group on Aerospace sector had advised the formation of a National Aeronautics Commission. As per their report, there are a number of aeronautics organisations like HAL, NAL, DRDO laboratories, ADA, ADE, GTRE, IISCs, and IITs etc. in the country. All the knowledge residing in these entities can be synergistically harnessed by a National Aeronautics Commission. The commission should map indigenous capabilities, identify knowledge gaps, direct resources efficiently to address critical technology gaps. [4]

E. Absence Of Lead Industry Trainers And Lack Of Training And Certifications For Aerospace Professionals

The government does focus on the development of primary skills but product specific/ relevant skills demand an enhanced focussed approach. The development of skills in the defence industry needs a guided and wholesome approach between the government, industry and academic institutions to integrate their objectives together. [5]The conspicuous absence of an Industry trainer is an opportunity for HAL to utilize and materialize. [12]

IV JOURNEY OF HAL

Hindustan Aeronautics Limited (HAL), a Navaratna Public Sector Undertaking, is Asia's premier Aerospace Complex. HAL has played a major role in the Defense aviation of India through design, manufacture and overhaul of fighters, trainers, helicopters, UAVs, transport aircraft, engines, avionics and system equipment. Its product track record consists of 15 types of aircraft from in-house R&D and 14 types by license production inclusive of 8 types of aero engines and over 1000 items of aircraft system equipment (avionics, mechanical, electrical). [10] The Company has the requisite core competence base with a demonstrated potential to become a global player.

Today, HAL has 20 Production Units and 10 Research & Design Centers in 8 locations in India.

In order to meet with the challenges in the 21st Century, the Company has defined its Vision and Mission as follows:

Vision

“To become a significant global player in the aerospace industry”

Mission

"To achieve self-reliance in design, development, manufacture, upgrade and maintenance of aerospace equipment diversifying into related areas and managing the business in a climate of growing professional competence to achieve world class performance standards for global competitiveness and growth in exports".

HAL has successfully designed & developed the Advanced Light Helicopter, which is currently being operated by the Defense Services of India and private Companies. The Advanced Light Helicopter also has great export potential. The weaponized version of Dhruv- ALH MKIV is already in series production. Apart from license production of front line fighters like Su-30 MKI, HAL is also developing the following products through design and development: -- Intermediate Jet Trainer (IJT) -- Light combat helicopter (LCH) -- Light utility Helicopter (LUH) -- Tejas-Light Combat Aircraft.

HAL as the pioneer in country's Aerospace industry has contributed immensely to mission of self-reliance and earned the reputation of being the “Force behind the forces”. The recent dedication of the indigenously designed and developed Light combat helicopter LCH and indigenously upgraded version of Hawk aircraft Hawk-i to the nation by the Defence minister are shining examples of our capabilities. HAL has been involved

in developing an Aerospace ecosystem in the country through Technology development & Diffusion. This will ensure stabilised economic growth and boost the much needed self reliance of the country.

The volatile and changing business environment offers HAL an opportunity to review its strategy and re-jig itself as the leader in developing a sustained Aerospace ecosystem in the country. [19]

V VUCA WORLD

Projects these days are becoming more and more complex and uncertain. They are characterised by what are known as VUCA factors.

VUCA stands for volatile, uncertain, complex & ambiguous.

1. **Volatility:** Volatility refers to the nature, speed, volume and magnitude of change in the project environment that demands more rapid decision making. The changes occur rapidly and unannounced that they cannot be predicted accurately where Classical strategizing fail.

2. **Uncertainty:** refers to the direction of change and if at all a change is imminent. Black swan events (sudden unpredictable changes) impact the project more than ever before. These uncertainties make it difficult for leaders to use past issues and events as predictors of future outcomes, making forecasting extremely difficult and decision-making challenging.

3. **Complexity:** This refers to the multitude of forces impacting the course of the outcomes of a project. This multitude of forces creates chaos and confusion and distorts decision making.

4. **Ambiguity:** Ambiguity is the lack of clarity about the meaning of an event: who, what, where, how, and why' behind the things that are happening are unclear and hard to ascertain. With the result, the Project Manager is not able to make meaning of the developments unfolding and hence unable to accurately conceptualize risks to a project and take mitigating actions.[13]

Strategy is an integrated and deliberate set of choices planned and executed across projects in an organisation. The objective is to develop sustained competitive advantage to meet the business objectives. Classical strategizing tools make two assumptions:

- The Enterprise Environmental factors, the EEFs are given.
- Future is predictable and is a linear extension of the past.

But the VUCA world is more malleable and the future is less predictable than we think it is. This pre-empts any reasonable long term forecasting wherein classical strategizing will fail. Hence a VUCA world of business needs a VUCA strategic approach, to meet the various combinations of unpredictability and malleability. [13]

Four strategic frameworks: Classical, Visionary, Unifying and Adaptive strategies (VUCA strategies).

There could be three major approaches other than the classical approach to a VUCA environment:

(i) **Anticipatory** - The ability to be quick and responsive to the changes with agility characterizes such organisations. However for long gestation, slow responsive projects like the Aircraft building agile management alone will not be sufficient; especially considering a PSU requirement of transparency, procedures and accountability.

(ii) **Adaptive** - This approach involves believing that the organisations would continue to be the lead drivers and be able to mould the industry in their segment downplaying the impact of market forces as well as technological changes happening in the environment. The danger of this status-quoist approach is very high as it can transform a once 'market leader' from 'now here' to 'nowhere'. Eg: Kodak, Nokia

(iii) **Collaborative** - This is a kind of 'Uniting/Shaping' strategy to counter VUCA, wherein companies engage with other stakeholders and create a joint vision, build platforms through which they can exercise influence and orchestrate the collaboration. In this inclusive approach, catalysis replaces control and collaboration replaces competition. Collaboration leads to developing of multiple hands to complete a project; an ambidextrous approach. [13]

The most effective approach is a collaborative approach driven by project management preceded by predicting & Leading 'VUCA', Anticipatory planning, Strategic foresight, Foretelling 'black swan' (unpredictable/less likely) events. [15]

VI BUSINESS SCENARIO ANALYSIS IN A VUCA WORLD – A PSU PERSPECTIVE

Globalization and open international market has forced most of defence organisations to look for opportunities to sustain their market presence in wake of intense competition, few buyers, diminishing margins, supply chain constraints, budget limitations, need for sustaining high technological expertise, talent management, speed of technology change and obsolescence at a faster rate than ever before.[5] [1]

The first strategic insight any Industry needs to develop is foresight of the trends in market needs, technological changes and competitive forces. Scenario building and extrapolating forecasting approaches are used to map the future landscape. [13]

Some of the public sectors like ITI and HMT believed that they would continue to be lead drivers and mould industry in their segment and downplayed the impact of market forces and technological changes and so could not catch up.

Meanwhile, other PSUs foresaw the unfolding scenario and did major re-jigging of their strategies to sustain and grow in a competitive environment even when they didn't have undisputed control over the market or business. Some companies like ONGC and BHEL diversified making 'Collaborative' efforts including joint ventures and joint marketing in areas where the PSUs don't possess adequate penetration and addressed issues of operational efficiencies, quality and customer support imperatives.

The PSUs can no longer influence the industry and Government as the owner should encourage and enable them to evolve and execute breakthrough strategies. However, wherever there are complementary PSUs in industry, they need to network and synergise their respective strengths rather than having an adversarial relationship. PSUs need to acts as Propellants of economic growth through technology infusion and building up of the supply chain capabilities of the ecosystem which will truly make them leaders with evolving roles. [13]

VII HAL STRATEGIES IN A VUCA WORLD

Stakeholder uncertainty, Supply chain uncertainty, Technology complexity, Skills ambiguity, HR challenges, scope uncertainty, Market uncertainty, Strategic risks, Competitor uncertainty are identified as the top VUCA drivers for the organization.

HAL has incorporated salient project management approaches in its new design projects to address and exploit the opportunities provided by the VUCA environment.

-) Collaborative strategy - to develop an Aerospace ecosystem
-) Anticipatory strategy - to develop & diffuse technology
-) Sustained supply chain - to propel economy into a Job-oriented growth

HAL has adopted collaborative approach in the Research, development, manufacturing, marketing and maintenance domain. [19]

Some of the initiatives are highlighted here:

-) HAL and BEL have jointly initiated the formation of Defence Innovation and Research Institute (DIRI). Under this initiative HAL & BEL will fund specific technologies for upcoming projects to private entrepreneurs and researchers so that when the project gets rolling, the technology is in place.
-) This incubation centre will provide technology for Aerospace MSMEs which will lead to greater indigenization and self-reliance in defence technologies supporting the 'Make in India' mission.
-) HAL and Pawan Hans Limited have signed a Memorandum of Understanding (MoU) for Helicopter operations and Pilot training.

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- J HATSOFF, a joint initiative of HAL and CAE, Canada, is aimed at providing on ground training to pilots through simulators
 - J Establishing JVs, MoUs and joint initiatives with companies is aimed to convert ‘COMPETITION’ to ‘COLLABORATION’. [19]

The Anticipatory strategy involves a back-casting approach. **Backcasting** is a planning method that starts with defining a desirable future and then works backwards to identify policies and programs that will connect that specified future to the present. In statistics and data analysis, backcasting can be considered the opposite of forecasting. It is a method in which the future desired conditions are envisioned and steps are then defined to attain those conditions, rather than taking steps that are merely a continuation of present methods extrapolated into the future. [20]

VIII ROLE IN TECHNOLOGY DEVELOPMENT

HAL’s role in technological growth through technical up gradation and supply chain capability is noteworthy. The Aerospace industry paves the way for entry of Aerospace technology into the country and HAL is the frontrunner in this aspect. The company has acted as a catalyst to drive technology entry through partnerships, license production (MiG series, Jaguar, Sukhoi-30, Hawk aircraft), collaborative designs, production through partnerships and through indigenous products (Advanced Light Helicopter, Light Combat aircraft). [19]

The key technologies developed include:

- (i) Composites
- (ii) Smart materials
- (iii) High precision manufacturing

IX PROPELLANT OF INDIGENOUS SUPPLY CHAIN ECOSYSTEM

There is a growing need to not only develop in-house capabilities but also support ancillary units, MSMEs etc upgrading capabilities of supply chain to meet increasing demands.

- a. Leading Supply chain for Automobile, machine tools and allied tertiary sectors, upgrading capabilities to meet AS standards in terms of equipments, processes, quality systems by partnering with HAL
- b. Developing supply chain in niche areas – Mg, Ti/composite machining which is not prevalent in the industrial ecosystem
- c. Aspects of Stakeholder and Procurement management have to be imbibed in ensuring effective supply chain which is wide in sourcing and dependable on delivery aspects.[19]

The key areas of supply chain developed include:

- (i) Composites
- (ii) Smart materials
- (iii) Precision components

X PROJECT MANAGEMENT LESSONS FROM A&D INDUSTRY

There is a growing need for organizations to adopt best practices in Project management in order to take the lead in propelling the volatile environment and contribute to economic growth and technological capabilities. It is suggested that such a transformation could be characterized by adopting the ‘Anticipatory’ and ‘Collaborative’ approaches as response to challenges, strengthening the business process through comprehensive scenario analysis and ‘predictive planning’ approach with alternative action plans. [12]

Increased autonomy of decision making within the realms of public accountability and probity, both at the organizational level and the operating level, effective change management and ‘proactive business approach

in the areas of business scenario analysis, contingency planning, and risk management would create an environment conducive to radical and disruptive innovations at organisations. [11] Refer fig 2. [18]

Some of the Project Management techniques that can be adopted by companies to respond to VUCA environment include:

A. Early and Deep stakeholder engagement

) Supply chain uncertainty:

In order to tackle the uncertainty in supply chain, HAL is in process of converting from a



Fig 2: VUCA in HAL

vertically integrated organisation to a lead integrator, building capabilities more than ramping up capacity. Another measure involves developing supply chain especially Tier-II and Tier-III suppliers and MSMEs for prospective products. [18]

) Technology complexity:

Project management is a vital tool for technology management in terms of technology risks and Organisational Process Assets (OPAs) of the ecosystem. Technological complexity and obsolescence could be dealt by development of incubation centres for futuristic technologies in collaborative mode. HAL and BEL have jointly initiated the formation of Defence Innovation and Research Institute (DIRI) which is a major step in this regard. Also, HAL and BEL had signed an umbrella MoU in May 2016 that includes sharing of expertise in design, development, engineering and manufacturing to develop and produce advanced airborne communication, electronic warfare systems aimed at greater indigenization and self-reliance in defence technologies. This collaboration will support the 'Make in India' mission.

) Industry-academia collaboration:

Establishment of joint chairs with leading technological institutes like IITs ensuring sustained growth, ushering culture of innovation at low cost and knowledge repository enrichment besides fulfilling the common objective of providing service to the nation.

) Skills ambiguity :

As the industry is growing, there will be huge shortfall in skilled manpower in terms of industry-ready technicians, engineers and managers. Development of Aviation Skill sector council (ASSC) has been initiated

by HAL wherein around 60 skills specific to aerospace have been identified for designing and conducting training programmes on skill development for diploma trainees for absorption into the industry.

) Competitor uncertainty :

Competition from other players in the industry and new entrants is rising by the day and it can be handled effectively by the establishment of JVs with competitors to convert competition to collaboration.

B. Strategic risk Management

) Market risk mitigation :

(i) Investing in multiple question marks in the BCG portfolio matrix like Unmanned aerial vehicle (UAV), Naval rotary unmanned aerial vehicle (NRUAV), Unmanned combat aerial vehicle (UCAV) projects by HAL, which have potential to herald a leap in the Aerospace capabilities of country.

(ii) Scenario analysis and back casting –It is a potent tool to envisage the future and plan since defence projects have high gestation period. (Examples for HAL include Indian multi-role helicopter IMRH, 25 KN engine, Sukhoi fighter aircraft)

) Technology risk mitigation :

(i) Embracing Open system architecture in new product development such as Mission computers in order to have the technological agility to respond to changes in engineering.

(ii) Investing in products of the future – this is required for developing technology today for products of tomorrow (Examples for HAL include Cryogenic engine, 25 KN engine, UAV, UCAVs) [18]

C. Scope management and assumptions analysis

Scope management is a critical parameter wherein understanding the customer requirements and scope of deliverables is vital. It should involve questioning the assumptions which is essential to remove impediments put forth by the triple constraints. Clarity of implicit assumptions in the early stage of project leads to lesser uncertainty during execution stage. PSEs have learnt this most vital aspect the hard way with lot of scope changes due to changing customer needs and high expectations. [19]

D. Robust Change management processes:

While a fully defined scope is desirable in any project, the evolving technology and changing requirements of military applications necessitate changes during all project phases. Defence projects being of a long duration type, technologies and scope envisaged during the beginning of the project undergo multiple changes during execution stage and a robust change control mechanism enables successful completion of projects. The response to VUCA should be built into the processes. [18]

E. HR management:

There is an increasing need to create a 'Learning organisation' nurturing new and expansive patterns of thinking by effective knowledge management, talent management and HR management including formation of cross-functional teams fostering innovation. [11]

XI CONCEPTS AND LESSONS FOR THE FUTURE

Project management is an effective means of handling projects and programmes in aerospace domain. There is a growing need for organizations to adopt best practices in Project management in order to take the lead in propelling the volatile environment and contribute to economic growth and technological capabilities. There are some challenges posed by the industry and changing geo-political dynamics for aerospace companies that necessitate them to focus on innovative new products, tackling technology obsolescence to meet the requirements of prevalent and future warfare and defence scenarios. This underlines the need to revamp the product portfolios of the aerospace companies and work on collaboration mode to effectively tap into defence requirements. [19]

XII CONCLUSION

Therefore, the key to sustenance and being engines of the country's growth in the VUCA world for a PSU like HAL, is the need for being the harbinger of technology entry into the country, creating a sustainable supply chain creating jobs, leading the VUCA, encouraging 'Collaborative' and 'Anticipatory' attitudes to be built into the business strategy as well as in the process of managing portfolios/projects to deal with unpredictable situations that offer a truly sustainable competitive advantage.[19]

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