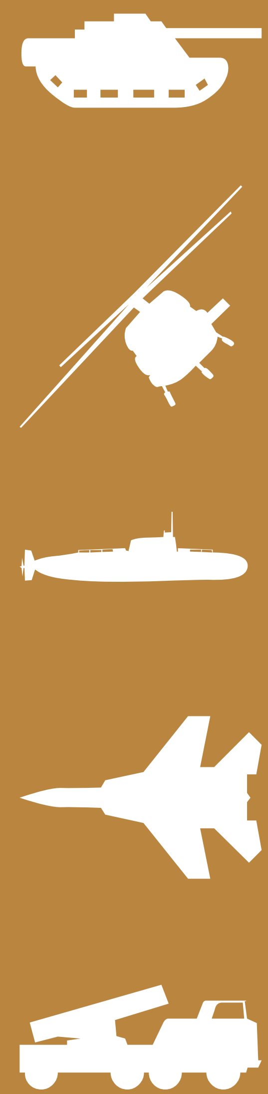
VIF TASK FORCE REPORT



Make In India

Through Indigenous Research and Development by DRDO/Industry

Vivekananda International Foundation

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Foreword

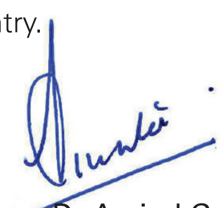
India is one of the largest importers of defence equipment in the world. Compelled by the need of modernise its armed forces, India will be importing billions of dollars worth of equipment in the next ten years. The growing dependence on imported defence equipment and technologies not only places heavy burden on financial resources, it also impacts national security adversely. There is an urgent need for accelerating the tempo of indigenisation of defence production.

India has several remarkable achievements in the indigenisation of critical systems such as guided missiles, light combat aircraft, and strategic sub-surface platforms etc. Yet, given the huge requirements of the armed forces, a lot more needs to be done to make an appreciable impact on defence imports. The government has taken several steps in recent past to encourage indigenous defence production and launched the "Make in India" programme. The results of these efforts will bear fruits in the coming years.

In order to examine the reasons as to why India's efforts at indigenisation of defence production have not met with the expected success and what needs to be done to accelerate indigenisation, the Vivekananda International Foundation set up a Task Force of experts under the stewardship of Vice Admiral (retired) Raman Puri. The Task Force critically examined the prevailing situation and the lessons from the successful programmes and projects of Indian Space Research Organisation, Defence Research and Development Organisation and tried to understand how they can be applied in all areas of defence production.

The Task Force has gone into the details of the indigenisation process and identified the gap areas. It recommends a thorough reform of defence planning process and suggests restructuring of higher defence organisation. The key recommendations is that there is a need to evolve a meaningful Long Term Integrated Perspective Plan (LTIPP) which would help the future programmes and projects to build indigenous defence capability. The Task Force also identifies certain critical programmes in which indigenous capacities need to be built such as conventional submarine and nuclear attack submarine, hypersonic missile systems, integrated ballistic and cruise missile system, a series of aviation programme, AI enabled autonomous system, cyber security system and the raw material required for production for critical materials.

It is hoped that the Task Force report and its recommendations would be found useful by the government in promoting indigenous defence production in the country.



New Delhi
15 February 2019

Dr Arvind Gupta
Director, VIF

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This project would not have been possible without the kind support and help of many individuals and organisations. I would like to extend my sincere thanks to all of them.

I am highly indebted to Vivekananda International Foundation (VIF) for this initiative and constant supervision as well as for providing the necessary platform to bring together all the expertise regarding this project and also for their support in completing the project.

I would like to express my gratitude to Brigadier (Dr.) Anil Sharma (Retired), Lt. Gen. A.V. Subramanian (Retired), Shri Amit Cowshish (ex-FA Acquisition), Rear Admiral Sanatan Kulshreshtha (Retired), Commander Dinesh Singh (Retired) and Dr. Kota Harinarayana who were members of this Task Force, for their kind cooperation and encouragement which helped the team in completing this project successfully.

I would like to express my special gratitude and thanks to various retired service and DRDO officers and those from industry for giving very useful suggestions to achieve the objective of Make in India through indigenous research and development.

My thanks and appreciation also goes to the research team of VIF, and Mr. Ankit Singh, Young Professional, VIF, for assistance in the project.

Vice Admiral Raman Puri (Retd.)
PVSM, AVSM, VSM
Distinguished Fellow, VIF

New Delhi
15 February 2019

List of Abbreviations

AAP	Annual Acquisition Plan
AI	Artificial Intelligence
ASR	Air Staff Requirements
ATV	Advanced Technology Vehicle
AWACS	Airborne Warning and Control System
CCS	Cabinet Committee on Security
DCPP	Defence cum Production Partner
DPP	Defence Procurement Procedure
DPPS	Defence Procurement and Production Strategy
DPSU	Defence Public Sector Undertaking
DRDL	Defence Research & Development Laboratory
DRDO	Defence Research and Development Organisation
EW	Electronic Warfare
FYP	Five Year Plan
HAL	Hindustan Aeronautics Limited
HQ IDS	Headquarters Integrated Defence Staff
IDDM	Indigenous Designed, Developed and Manufactured
ICT	Information and Communication Technology
IAF	Indian Air Force
IFDG	Integrated Force Development Guidelines
ISRO	Indian Space Research Organisation
IGDMP	Integrated Guided Missile Development Programme
LCA	Light Combat aircraft

LTIPP	Long Term Integrated Perspective Plan
LTTPP	Long Term Technology Perspective Planning
MBT	Main Battle Tank
MBRLS	Multi Barrel Rocket Launched Silo
MoD	Ministry of Defence
OEM	Original Equipment Manufacture
OFB	Ordnance Factories Board
PNC	Price Negotiation Committee
PoC	Proof of Concept
RFI	Request for Information
RFP	Request for Proposal
QR	Qualitative Requirement
ToT	Transfer of Technology
TPCR	Technology Perspective and Capability Roadmap
TRL	Technology Readiness Level
UAV	Unmanned Ariel Vehicle

Chapter 1: Introduction – Achieving Indigenisation Goals

1.1 Felt Necessity

India is gradually metamorphosing from a regional player to a country with global clout. As its geo-political and economic ambitions grow, it needs to develop robust indigenous manufacturing capabilities and an ecosystem to secure its ambition for self-reliance in the aerospace and defence industry.

> The current picture, however, is quite the opposite. India is ranked among the top 10 countries in the world in terms of military expenditure. Between 1995-2000, India was the sixth largest arms importer, the bill being USD 7 billion which was around 50 percent (in terms of value) of what Taiwan, the largest importer had spent. As per reports published by the Stockholm International Peace Research Institute (SIPRI), in the last five years (2013-2017) India has spent USD 18 billion which is more than 12 percent of Saudi Arabia, the second largest importer, making India the largest arms importer today. That is not all, if we add life cycle costs of spare parts, upgrades etc., seller nations finally end up earning many times the cost of platforms and systems that they export.

That we are the **only importer of arms amongst the global powers**, must act as a dampener and reality check for our leaders, as historically, no nation has ever earned respect, safeguarded its freedom and followed an independent foreign policy on the strength of imported arms and ammunition. **Exporter countries have leverage over us which they invariably use during geo-political crisis situations where our vital interests are perceived to be clashing with theirs. In the past, our strategic choices had to be diluted and even rolled back due to such dependencies.** Furthermore, it is extremely puzzling that a nation that suffered colonial rule for long and projected independence of foreign policy as a badge of honour, never rectified or nullified this 'dependence' and restrictions imposed by arms imports.

In FY 2018-19, the government has allocated about 1.58 percent of its GDP for defence spending, **which is being termed as inadequate by experts.** Owing to a dynamic security environment and the toxicity of our neighbourhood, India's defence requirements are likely to surge in the foreseeable future.

The government has declared its intention of procuring defence products worth billions of dollars annually over the next five to ten years. Even though India has moved into the world's top defence spenders club (accounting for 13 percent of global arms imports), nearly 70 percent of its capital expenditure is on imports.

> Following this trend, nearly USD 7 billion worth of procurement would be through imports. This would make our defence budget unsustainable due to life cycle costs of capital acquisition as also the concern of an ever rising revenue budget disrupting the fine balance needed between the two.

In contrast, China's share of global defence imports has dropped to 4.5 percent between 2012 and 2016, from 5.5 percent between 2007 and 2011.

Russia continues to be India's biggest defence supplier, even though both the US and France are competing hard to emerge as alternative top and strong suppliers. It is quite apparent that major arms exporting countries have realised that with a weak defence industrial base and a continuing two-front conventional threat, besides nuclear and hybrid war threat perceptions, India's appetite for imported defence equipment is going to be virtually insatiable. Thus, it greatly serves their business and geopolitical interests to ensure status quo **by adopting various measures to prevent the emergence of a robust indigenous defence capability. Further, such imports often bind us to their domestic laws, for them to derive long-term advantages.**

The rapidly changing regional and global security challenges have forced countries across the world to rethink their defence strategies and plans. This is certainly the case in South and Southeast Asia. The rapid proliferation of dual-use technologies, blurring of external and internal security challenges and the shrinking of the design cycle with the **production cycle** has synergised the military and civilian industry to the extent that leading players in defence capability localisation also lead in industrialisation.

It is clear from ongoing arguments that India has to pull out all stops to attain its stated but not successfully pursued goal of developing indigenous defence capability.

> Tapping its globally recognised scientific and engineering talent, and harnessing it for indigenisation-led modernisation of the armed forces needs to be made a top priority of the government. We should not limit ourselves to 70:30 ratios, etc., but aim for total self-reliance. It is important to flag here that 'Make in India' should imply conceptualisation of an indigenous system that meets our capability needs in terms of design, development and production. It should not be defined by the percentage of indigenous components fitted which leads to subjective interpretations most of the time. The issue of indigenising electronic components in our system also needs to be examined separately.

1.2 Study Perspective

Efforts for indigenisation date back to the early nineties when a committee chaired by the late **Dr. A.P.J. Abdul Kalam,** made specific recommendations with regard to the import/export ratio of defence equipment. Finally, limited private sector participation was allowed in 2001. In order to usher in meaningful participation, another committee led by **Mr. Vijay Kelkar** was appointed 13 years ago. It recommended the opening up of the hitherto closed defence production sector to domestic and foreign private players. **At the time, some 50 percent of the Indian military inventory was rated as obsolete and some 70 percent of new equipment was imported, with minimal or no technology transfer.** The understandable intent was to reverse this to just 30 percent imports within a decade. However, despite the Indian government's repeated policy assertions to reverse the import to domestic defence production ratio from 70:30 to 30:70, this has not been possible till now. This aspect seriously impacts the country's defence preparedness. Be it Kargil or the Doklam episode, our dependence on imports showed starkly when our Services had to go abroad on buying sprees at very crucial junctures.

The defence capability accretion process in India has been vacillating between modernisation and indigenisation. In general, defence capability is sought to be built through Buy/Buy and Make/Make Processes. The Defence Procurement Procedure (DPP) 2006 had for the first time included a 'Make' procedure. The DPP has subsequently undergone several revisions right down to the last one in 2016. The new term to enhance indigenous production is now called Indigenous Design, Development and Manufacture (IDDM). The DPP 2016, except for the new IDDM feature, fails to boost indigenous design, development and production, and bring about much needed transformation. Even in the IDDM we can have a system with 60 percent of indigenous content where in essence it still leads to licensed production.

From data available in the public domain, it can be clearly inferred that building capability through the Buy route is clearly unsatisfactory on grounds of low effectiveness of many of the procured systems in performing to our 'Mission Needs' especially in the environmental extremes peculiar to our areas of operation, vulnerability to supply chain breakdowns and high costs both on capital and revenue accounts, often leading to sub-optimal investment in ammunition (including missiles) and other lines of development that make a system effective.

The Buy and Make route where manufacture is sought to be undertaken through TOT (Transfer of Technology) studies, clearly shows that 'technology' is far from transferred and what we achieve is just licensed production with some value addition but dependence remains on critical components, software, and so on. The ill effects of Outright Buy, to a large extent apply to this route also. The country's economy also suffers because of such purchases as the industry hardly gets any technology infusion that can be horizontally diffused due to end user certification and other restrictions imposed, and export potential thus cannot be possibly exploited. Further, R&D (Research and Development) and technology development in the country suffer as we land up paying extremely high R&D costs to other countries. In this, very little benchmarking is feasible anyway as many Price Negotiating Committees (PNCs) and service negotiations end up without showing any gains of 'technology' infusion.

The net result is that despite numerous revisions and policies, private industry remains pushed to the sidelines and imports dominate unabated. Unfortunately all DPPs tend to reinforce the policy paradigm – the more things change, the more they remain the same, and ultimately, we continue in the situation of BUY whatever we can and build only that which we must. This is clearly unsustainable. **Ultimately, not only will the budgeted capital account not suffice, but also, revenue budgets will fall short of requirements, greatly affecting combat readiness.** Also, the large diversity in platforms and systems arising out of our current procurement processes makes logistical management an uphill task, leading to deficiencies in combat readiness. **This phenomenon has already set in.**

Considering the above situation, the Vivekananda International Foundation (VIF) had organised a Round Table in 2018 with concerned stakeholders from the HQIDS (Headquarters Integrated Defence Staff), Services, DRDO (Defence Research and Development Organisation) and industry to consider fundamental reasons for our inability to reverse the domestic armament content. It emerged that 'BUY' or 'BUY and MAKE' are largely modes adopted for our defence requirements today. Despite written commitments in contracts, transfer of technology does not take place and dependency on Original Equipment Manufacturers (OEMs) continues for critical spares, deep repairs and upgradation. Offsets have failed to bring in any meaningful technology, nor is ToT in the commercial or strategic interests of OEMs. They have not only got away by citing lack of local expertise to absorb technology, the accountancy focused approach of MoD further tends to reduce defence offsets to Excel sheets and meaningless numbers. This obviously imposes penalties on the state of our defence preparedness at huge financial costs. Also, the very procedures involved as per the DPP and DPM result in large time and cost overruns faced by the armed forces.

1.3 Terms of Reference

Keeping the foregoing voids in perspective, the Task Force investigated as to why we continue to be at around 70 percent import level. During the discussions with multiple stakeholders, many issues that stultify indigenous defence R&D and production were identified. These were coalesced together into the following key areas for proposed examination:

1. Consider the adequacy of currently available planning documents for formulating meaningful technology and development plans (i.e., Long Term Integrated Perspective Plan (LTIPP), Five Year Plans (FYP), Annual Acquisition Plans (AAP), and Qualitative Requirements (QR), based on which, R&D and industries are currently required to plan their technology and product realisation plans.
2. Development of Technologies and Proof of Concept (PoC) by Academia/R&D organisations/industries and identify challenges and the concomitant way forward.
3. Major road blocks and suggested improvements at the stage of prototype development (Financial and nomination issues, user and industrial interaction required and conduct of trials, leading to user acceptance, issue of timelines in various trials, etc.).
4. Impediments in limited series production and protracted post-production acceptance.
5. Entry into service, obsolescence management and mid-life upgradation

(attendant role of industry, DRDO and users).

6. Inability of procurement procedure to encapsulate costing uncertainties of participating industries associated during R&D.
7. Methodology
8. The case study and further analysis to cover the scope indicated has been undertaken based upon:
9. Data from the authentic stakeholders and sources as far as feasible.
10. Analysis of global trends and open source information.
11. Models of foreign countries like Israel and USA will also be examined.
12. The project will be evolved by undertaking case study of Project AKASH, LCA, and ATV in the backdrop of the provisions of DPP as modified from time to time till DPP 2016.

1.4 Research tools used

1. DRDO data as available in the public domain.
2. Focus group interaction with industry and DRDO retired scientists.
3. Discussions with HQ IDS, Service HQs on user perceptions.
4. Interaction with MoD (Acquisition Wing, Defence Production and Finance).
5. Literature review of global trends and open source information.

1.5 Study Layout

Consequent to discussions and analysis thereof, the essential issues for study were grouped under two basic factors.

1. How do we set the requirements of the armed forces to achieve our goal of realising their needs through indigenous research, development and production?
2. The process to be adopted thereafter to meet these requirements efficiently through indigenous research, development, trials, evaluation and production.

This report covers the first aspect

The study has been laid out as follows:

1. Chapter 1 – Introduction: Defining Conceptual Framework.
2. Chapter 2 – Setting the Requirements for the Armed Forces.
   - i. Make in India and the DRDO.
   - ii. Models adopted by some foreign countries.
   - iii. Lessons from case studies/ programmes and projects, ISRO, IGMDP, AKASH, LCA and Strategic Subsurface Platform.
   - iv. Evaluation of TPCR and DPP 2016.
3. Chapter 3 – Arriving at Capability Needs: Evolving LTIPP and Beyond.
4. Chapter 4 – Gap areas and recommendations.

Implementation also needs detailed study and will be examined as a separate aspect.

Chapter 2: Setting the Requirements for the Armed Forces

SECTION 1

2.1 'Make In India' and the DRDO

In September 2015, the government launched its flagship programme 'Make in India', to focus on 25 sectors of the economy for job creation and skill development. The government set a target of increasing manufacturing output to 25 percent of national GDP from 16 percent currently. The Aerospace and Defence sector was designated as a promising and targeted sector with the objective of increasing local manufacturing, reducing imports and dependence on foreign OEMs and improving the self-reliance quotient.

'Make in India' initiatives of the government have driven a number of policy changes in FDI, Defence Industrial Licensing, Defence Exports, and above all, the Defence Procurement Procedure (DPP). These call for major efforts towards capability and capacity buildup in the acquisition setup to address and manage private industry partnerships which are expected to emerge in the defence sector.

Significant indigenous development of weapon systems primarily rests with the DRDO as it is the only organisation mandated for weapons and systems with IPs, designs and know-how in defence technologies. Once development is complete, the DRDO transfers technology to Indian industries for military and non-military applications, and for commercial exploitation by industry.

The DRDO has played an important role in creating critical indigenous capacity in the defence sector. There are several examples of successful cases. Platforms like MBT ARJUN, LCA TEJAS, AKASH weapon system, strategic missile systems – whether AGNI or PRITHVI and their variants, Radars, PINAKA MBRLS, EW Systems, Sonar and underwater systems – all of these and more are indigenously designed, developed and inducted/under induction after successful trial evaluation, though with some time delays.

With the emphasis on 'Make in India' in the defence sector, the DRDO needs to take a lead in altering the contours of the Indian defence production industry. Even in ICT, as the context, data as also the protocols are unique to security requirements and the private sector is unlikely to find a business model to support these needs. DRDO has thus a significant role to play both for development of strategic technology items, enhancing domestic capacity through 'Make' procedure by handholding as well as partnering with industry and provide design and development support to the Services, making available the lab and trial infrastructure to industry, transfer of technology and productionisation.

It is, therefore, imperative that case studies and lessons emerging from Foreign Service models and own successful programmes and projects, be analysed for arriving at meaningful deduction.

SECTION 2

2.2 Models Adopted by Some Foreign Countries

All advanced nations have evolved and instituted robust structures, systems and processes for building their defence industrial base while continuously meeting the demands of their Armed Forces, aligned with their enlightened self-interest. The succeeding paragraphs highlight key features of a few countries, with deductions from Israel and USA amplified. Details of Israel and US models are given in a separate reading package.

2.2.1 Israel

Israel's armament strategy flows out of its national security and military strategies as guiding documents. It is shaped by the constant threat to national survival, frequent history of warfare and the robust technical skill base of its emigrated personnel. These have been major factors in the growth and quality of her defence industrial base. Israel has traditionally viewed arms exports to be an important component of its foreign policy and military strategy, and not simply as a complementary source of revenue for her defence industrial base.

A deliberate component of Israel's armament strategy is the requirement for its defence industry to seek funds from the export market. This includes cooperative developments with corporations in foreign countries, especially the US and European giants. The intent is to promote exports of the entire defence industry – government institutions, public companies, or private companies – in support to the overall policy of the Israeli government, which perceives defence exports as a 'central objective'. Exports are intended to further R&D in Israel and also strengthen Israel's defence industrial base capabilities to provide armaments to the IDF. Israel's privately-owned defence companies have been somewhat successful in downsizing and reworking their export strategies to focus on specific customer needs.

Israel has moved towards a niche strategy in which they domestically produce armaments for those areas where they have global competitive advantage and import, using military assistance funds, platforms that can be modified to meet their own needs and those of their export customers in view of the geopolitical alignments available to them (which is not so in our case). When the Israeli defence budget began to shrink, private defence companies reoriented and concentrated on building customised export products tailored to meet the requirements of specific customers, rather than developing so-called state-of-the-art equipment all the time (quite unlike the Indian model). Israel follows a very fine economically motivated and balanced approach, between the need to continue arms exports to new markets such as China and India, and the parallel need to receive US aid and armaments in the face of US objections to Israeli arms exports to those countries.

Comparative Evaluation

1. Israel-India. Israel's defence industry received a fillip after the 1967 war, initially to supplement French imports and subsequently with a French embargo, as an indigenous enterprise.
2. After 1971, a similar relationship was developed with the US. The Israel defence industry has developed as a collective security partner of the US. Even now most ventures are cooperative or joint with the US or other western countries. In order to survive, the Israelis have found defence self-reliance to be the only solution.
3. Their four pillars of defence (MoD, armed forces, R&D and industry) are seamlessly integrated through defence planning guidelines and defence exports are used as a very effective foreign policy instrument (this synergy does not exist in the Indian defence enterprise except in the strategic arena to some extent).
4. National security strategy, theory of war, military capabilities for present and future wars are unambiguously translated into a national armament strategy, armament requirements, import and export strategy, military industrial cooperation and continuous restructuring of the defence industry.
5. In glaring contrast to the Indian system, the Israeli government works to promote close cooperation between the Israeli Armed Forces, R&D and defence industry in the pursuit of common security objectives. Allocation to R&D has varied from 8 to 20 percent of the defence budget.
6. Despite major differences in terms of a possible security concept India can adopt, huge socio-economic challenges and its large size, there are considerable lessons to be learnt in terms of creating a sustainable ecosystem for research, development and production infrastructure to flourish. Above all, there is a need for a change in mindset for achieving the required goal of self-reliance in defence.

2.2.2 USA-India

1. The US has evolved an elaborate and multi-tiered system to arrive at acquisition decisions as also the export of technologies. In QDR 2005, in addition to the countries of security concern viz., Russia, Iran, North Korea, and Cuba; China and India were labelled as countries at strategic crossroads. These countries were sought to be engaged to align them with US policies. Yet, at the same time, capabilities were to be developed against them, including more robust nuclear ones. Can there be a bigger cause for India to develop defence self-reliance rather than rushing in for straight buy decisions with all and sundry?
2. Americans have many allies. This alliance dominates the global technology base with the Americans leading it. The much hyped up free market as far as defence equipment,

systems and ammunition impacting national security goes, is in practice confined to the allies and strategic partners. It is inconceivable that they would share technology with their competitors or potential strategic adversaries. Hence, it is export of technology which is of concern. All free trade and buy favouring factors are relevant for geopolitical/geo-strategic alliances or partnerships which have matured over the years. India is still not anywhere near the inner circle as national interest driven geopolitical compulsions necessarily follows a standalone/ regional security concept rather than an intercontinental collective security alliance/partnership with the USA.

Deductions – Strategic and Defence Planning

1. Common deductions drawn have taken into account models being followed by other major powers, besides the USA and Israel, as they merit comparison with India. These are Russia, France, Britain and China.
2. All these countries have become major military and political powers by **first developing an indigenous defence capability for their security needs** with or without cooperation from their allies. Later on, defence capacities created were used **for export to earn revenues as also attain foreign policy objectives**. India, perforce, has to be in this league to meet its stated/implied National Policy Goals.
3. Their defence planning, technology creation, defence finance oversight and acquisition systems were organised strictly according to their **security/strategic needs, emanating in an institutionalised manner from the political system in the form of strategic guidance documents**. For example, within 150 days of taking over, the President of the United States has to get the NSS of his administration approved by Congress. Within the next 30 days, National Defense/National Military Strategy (NDS/NMS) has to be ready. Work on the Quadrennial Defense Review (QDR) commences concurrently which has to be approved and promulgated within a year to facilitate a review of the defence acquisition system as per latest political directives. **Emphasis remains on the terminal state, that is, fielding and employment of capabilities created in the strategic/ operationally pertinent time frame**.
4. These countries realise that military capabilities (often only in being) are not only essential for war fighting, but their availability/perceptions deters and dissuades as also enhances the **strategic configuration of power**, thus getting leverages in geo-strategic tussles amongst competing players.
5. Accountability for **timely creation** of desired capability is very specific in their systems. **India, on the contrary, is aspiring to meet its colossal security needs not by a solid and reliable indigenous capacity through the Make process, but also through the**

Buy/Buy and Make capability from almost all arms exporting countries in the world, without any thought given to integrated architectures, promoting interoperability across a family of systems and system of systems and compatibility among related architectures. Artillery gun acquisition for example has been delayed so much despite capabilities being available that it has affected our dissuasive posture against major adversaries and they have been exploiting our weak strategic configuration of power through their increased intransigence. The list can go on endlessly and to a great extent this is also due to the fact that with a huge inventory, affordability continues to be a challenge.

6. In India's case, the system of pinpointing accountability is so diffused amongst all stakeholders that the buck only stops at systemic deficiencies rather than on any particular stakeholder/decision maker. Yet efforts to overhaul the system seldom bear fruit.

7. Another dimension of long-term Competition Dynamics played out by foreign arms exporting countries is very often overlooked by us. Foreign arms exporting countries strategise to thwart India's indigenisation efforts/policies, which needs to be countered through unambiguous policies and implementation to achieve self-reliance. Israel has for example, a well-considered plan for building its defence industry, with India paying hundreds of millions of dollars annually for this purpose. In becoming India's biggest defence supplier, Israel has a hard-nosed strategy that our policymakers must grasp and emulate.

8. Since Israel does not market aircraft or ships, its defence companies have focused on the lucrative market for upgrading India's predominantly Russian weaponry, including MiG-21 fighters, ship-borne missiles and T-72 tanks. Their first step was to understand Russian technology for which Israeli defence companies accepted initial contracts at cost price to build their engineers' capabilities. With that experience gained – at India's cost one must note – Israeli systems designers progressively graduated up the complexity scale. Today, Israel's defence industry is with capabilities honed across a generation of systems. Even in systems developed with Indian finance, there is practically no transfer of technology. Production too is largely garnered by the Israeli industry.

9. The opportunities for Israeli defence industry in respect of Russian platforms are vast. Some 30,000 T-72 tanks are in service worldwide including 2,500 in India. But Israel, not India or Russia, will feed off that upgrade market. India provided Israel with the tanks, the opportunity and the money for creating that capability. Ironically, the Ministry of Defence (MoD) ignored India's own defence industry – its undeniable competence could have been as easily translated into capability. The Israeli industry garnered another windfall from its offer to build the Phalcon Airborne

Warning and Control System (AWACS mounted on a Russian IL-76 aircraft. No Israeli company had ever designed such an AWACS before, but India handed over USD1.1 billion (Rs. 5,000 crores) to Israel Aerospace Industries (IAI) and Elta. Hundreds of Israeli designers learned on the job, building AWACS capability on Indian money and operational know-how. Israel will now build another three AWACS for India, several for the Israeli Air Force and export more to Chile and Singapore.

10. **The essence of some of the country's defence export strategy appears to be that a financial loss would be acceptable in the near term, in order to curb Indian defence industrial capability.**

11. The US gains and dominance of technology regime is due to a large and tight network of global allies that it maintains to safeguard its national interests. International defence cooperation comes with risks which US allies with their own advanced defence industries may be able to withstand, but not India. Our capability can very easily be held to ransom. By glancing at the policies and objectives of US foreign military sales, it becomes very clear that by opting for larger-scale buy decisions without viable self-reliant capacity, **India runs a huge risk of compromising national security.**

12. Further imported capital purchases of arms results in continued dependency for critical spares, deep repairs and upgradation on OEMs which are governed by their national export control laws, and their commercial interests as stated in this paper. This effects our foreign policy options also and applies to all other arms exporters – European or Russian who would have similar goals while trading with a country that lacks adequate self-reliance in defence production capabilities. In the end, the benefits of modernisation of our armed forces through imports must be weighed against hazards of foreign dependency, high life-cycle costs, limited production technology transfers and diminished domestic R&D and production capabilities as also affordability.

13. India's defence planning procurement process needs to function in a synergetic manner and transform itself accordingly. **Information operations to garner support from the public should be aggressively pursued.** As the defence industry privatises and globalises further, increased information is necessary to monitor the industrial base. The MoD should take a deeper interest in data collection and brief the Parliamentary Committee on Defence on trends and findings. The MoD must study the entire defence R&D and industrial base and look at it like a target analyst. The department needs to understand centres of gravity and critical vulnerabilities to ensure a secure supply and manufacturing chain for the military and key Indian industries. The Ministry of Defence, Department of Defence Production and DRDO need to accelerate the vision for self-reliance in defence like other countries. **Dual use production**

facilities need to be created under sovereign Indian Public/Private Sector controls. Privatisation in these areas must mean creating capable Indian domestic R&D and an industrial base under sovereign control. India needs to learn beneficial lessons from American industrial and defence export policies and enact legislations necessary for the purpose. FDI and security related policies have necessarily to be restrictive in areas concerning defence and high-tech/ dual use technologies. What applies to sugar, steel, cement, and consumer durables etc., does not quite apply in areas of national security.

14. It would be clear from the above, that the essence of defence indigenisation is **to build domestic design development and production capability.** There is a need to stop these multi-vendor situations with global tendering. The concept of joint ventures between capable Indian R&D and Indian companies who then take **on the global competition** is the way forward and this needs support. It is time that the MoD lays out a **clear implementation and monitoring plan for a policy that would allow Indian companies (private and public) to build their capabilities with a credible assurance of business.**

Deductions – Acquisition and Production Stage

Key Deduction

It may be noted that the concept of **'spiral development'** is followed in countries like USA and France. The first variant of the equipment which meets the basic performance criterion is inducted as Mark I and further variants are inducted in batches with improved performance and other features. A highly successful aircraft such as the F-16 of USA has gone through 40 batches of production where each batch has had some incremental changes.

A spiral development approach should also be followed in India to enable the early induction of indigenous equipment and weapon systems. India lacks matured military-industry synergy, and the models of both USA and France are relevant for India, with the French model having great learning value for India.

In respect of the above, it is pertinent to highlight the following with regard to decisions of investment in R&D and production:

1. Technology matures with time and production volume.
2. Technology is dynamic and evolutionary in nature and this evolution can only take place with production and volumes. Technology if not used withers away and is lost. This is an important issue, as technology alone cannot survive if systems do not reach the production stage, as has happened in many cases in India.
3. Indigenous technology if not financially viable in the near term, needs to be pursued with resolve through spiral development as long-term benefits, including those of life-cycle cost, build up of industrial infrastructure specially in dual use domains will far outweigh seeming disadvantages in most cases.

2.2.3 USA

It is a very comprehensive, though complex 'system of systems', in which every acquisition function – the roles, responsibilities, authority and accountability of each key functionary – is clearly defined under the statute (Title 10 of United States Code).

1. It entails extensive scientific and quantitative analysis at each stage, from the selection of material solution to the induction of equipment for decision making.
2. Comprehensive reports are required to be generated at each milestone for seeking acceptance of the Milestone Decision Authority (MDA) and approval to proceed with the next phase of the project. The MDA is required to issue a written Memorandum of Acceptance or otherwise, with due justification for the decision, at each stage.
3. Defense Acquisition Executive USD AT&L (acquisition, technology and logistics) and Component Acquisition Executives (Assistant Secretaries in the Offices of Secretary of Army, Navy, and Air Force) are entrusted with full financial powers and authority.
4. The system has a well-designed structure to harness and synergise research, design, development and engineering capability from all avenues – integral laboratories, academic institutions, private R&D and industry. There is DARPA to focus on cutting edge technologies of the future. Spiral development is the preferred approach to speedy deployment of systems and weapons to the 'war fighter'.
5. Separate senior positions have been created in the AT&L set up to address small business, industry, and international cooperation.
6. The system is supported with strong legislations in respect of contracting, and single source procurements. It may be noted that in a report of the United States Department of Defense (DoD) in 2016, it was stated that 60 percent of their procurements were on a single tender basis despite large inventories, industrial capabilities and many attempts to have multi-vendor situations.
7. The Senate Armed Services Committee (SASC), and House Armed Services Committee (HASC), in addition to Defense Acquisition Board, provides comprehensive oversight to the whole acquisition system.
8. The Acquisition System is manned by a professional workforce called the Defense Acquisition Corp. Experts from all relevant disciplines, including Cost Estimation, Audit, Financial Management, System Engineering, Test and Evaluation, and Quality Assurance etc., are integral to the system. Components of the system are embedded in the DoD as well as in the Departments of Army, Navy and Air Force.
9. Personnel who perform activities of Requirements Development and Budgeting are not part of the Defense Acquisition Corp. Initial capability requirement documents are generated by Combatant Commands, which are subsequently validated by the Joint

Chiefs of Staff. Budget decisions are made separately – Director of Cost Assessment and Program Evaluation and Under Secretary (Comptroller) at the DoD level and similar positions at the Component (Individual Service) level.

10. There is a strong focus on continuous training and skill upgradation of personnel, to ensure their 'in date' professional knowledge as also to create opportunities for their career development.

11. The DAU (Defense Acquisition University) delivers the complete content for education, training and development of the acquisition workforce for military personnel, civil servants and industry personnel. Both classroom and online courses are conducted by the university.

2.2.4 United Kingdom (UK)

1. The UK MOD has embarked on major reform to shape its acquisition process. The change has come about after considerable evolutionary learning and critical thinking. Immediately after World War II, there was some similarity between the UK System and what was followed in India, but subsequently, it rapidly diverged because of changed system needs. The knowledge and skill of the acquisition workforce in heterogeneous areas was synergised under an organisation for achieving best value for money. The interim period of privatisation of state-owned companies during the 1980s had its telling influence on the shape of the UK's defence industrial base.

2. Coherent system requirements were evolved by the acquisition setup in which service personnel of appropriate seniority are embedded after special training. The financial and cost estimates are integrated in all stages, and hence, most decisions are evidence based.

3. As development of military systems is fraught with uncertainty, models include the risk sharing aspect of the acquisition. Single sourcing regulation has matured after the Defence Reform Act 2014.

4. The integration of acquisition with through life cycle management has given rise to an integrated view, whereby, issues of upgradation and obsolescence management are being addressed systematically now.

5. Many modelling tools are being used to enhance learning and support for the tractability of the process.

6. Integrated Project Teams are deployed appropriately with adequate oversight.

2.2.5 France

1. Direction Generale de l'Armement (DGA) is the body under the French Ministry of Defence that is tasked with procuring equipment for the French armed forces. The DGA's missions include preparing for the future and promoting defence exports.

2. The DGA is involved from the initial planning stage till the withdrawal from the service stage, covering a whole programme lifecycle of equipment. The DGA functions as

an R&D coordination and project management organisation; while production is done by the industry. The DGA does very little in-house R&D. Product design and development is done by the industry and research on future technologies is done by academic institutions or specialised labs, as tasked by DGA. The DGA is not an independent or autonomous organisation. It is a part of the French MoD.

3. The DGA is manned mainly by engineers and technical personnel. Its engineers do compulsory military service at the start of their careers. The integration of the DGA with their armed forces is of a fairly high degree.

4. Every armament programme originates on the basis of a need expressed by the armed forces. There are six clearly defined stages in the armament programme process. First two, Initialisation and Orientation, are under the leadership of the armed forces. The next two, Elaboration and Realisation, are under the leadership of the DGA. For the last two, In-Service and Withdrawal, the leadership is shared. Spiral development is the most preferred strategy.

France had a strong industrial and educational ecosystem in place much before the DGA was formed. Hence, the military and industry have matured over the years to synergise well for meeting the needs of the armed forces.

Chapter 3: Lessons From Case Studies – Programmes and Projects, ISRO, IGMDP, AKASH, LCA and Strategic Sub-surface Platform

3.1 Programmes and Projects

There are a few successful indigenous efforts which have enabled our Armed Forces to acquire and modernise relevant weapon systems. The IGMDP (Integrated Guided Missile Development Programme), development and induction of the AKASH system, induction of LCA and the Advanced Technology Vessel programmes are sterling examples. The salient lessons gleaned from these programmes give us the guideline for the design and development of future indigenous systems.

There are distinct programmes that have to be taken up to meet threats in areas such as:

1. Missiles
2. Manned Aircraft
3. Unmanned Air Vehicles
4. Underwater Sensors and Systems
5. EW Systems
6. Propulsion Systems
7. Sensors
8. PGMs
9. High temperature materials and functional materials

Each one of these programmes would consist of various **specific projects.** For example, in the case of missiles, we have **surface-to-surface missiles, surface-to-air missiles, cruise missiles, long-range ballistic missiles, tactical short-range missiles etc.** Depending on requests projected by the services and other users, individual projects have been launched, while the programme elements are yet to be launched, reasons being – overall threat perception, state of available infrastructure in the country and technology forecast.

Programme element and project element: In many organisations, including ISRO, development has two elements viz., the programme element and the project element. For example, in ISRO they have a Launch Vehicle programme and various launch vehicle projects such as SLV (Satellite Launch Vehicle), ASLV (Augmented Satellite Launch Vehicle), PSLV (Polar SLV), GSLV (Geosynchronous SLV), RLV (Reusable Launch Vehicle) etc. The launch vehicle programme would need technologies to be developed, infrastructure to be created, manpower to be recruited and trained, and test facilities to be established. These tasks are taken up as a programme element ahead of various projects. Funds are provided for the programme before any specific project is taken up. Such an approach is followed by many international organisations. In the MoD/DRDO, for conventional programmes, such an approach is largely not followed. As a result, considerable time delays occur, leading to costly imports.

Funding must be provided for the programme element ahead of the project element, thereby enhancing the maturity of technologies, enabling recruitment and training of manpower and creation of critical infrastructure in the MoD/DRDO. This will lead to early induction of indigenous systems.

3.2 ISRO

The Indian Space Research Organisation (ISRO) was set up in 1969 and its mandate is to harness space technology for the socio-economic benefit of the country, while pursuing space science research and planetary exploration. ISRO is closely linked with the Department of Space, which works directly under the Prime Minister of India. It is a long-standing tradition that the Chairman of ISRO has a career background within the agency and concurrently chairs the Space Commission. The same person also sits as Secretary of the Space Department and Chairman-cum-Managing Director of the Antrix Corporation. This point of common leadership, directly reporting to the Prime Minister, permits bureaucratic input while promoting a clear sense of purpose for achieving the aims of the agency. The ISRO initially had no intention to undertake any form of space exploration, wanting instead to focus on benefitting the common person. They have since been able to change their vision to include 'planetary exploration'. Consequently, without this degree of autonomy, the otherwise bureaucratic deliberation and inherent delays would adversely affect the efficacy of the agency and they would have been unable to change their vision.

India has positioned its space agency to treat the military as a stakeholder and client, with no direct influence over the policies, governance or operations of ISRO.

1. Around the mid-70s, ISRO took major initiatives to define organisational mechanisms to promote technology transfers from its centres to industry with the aim of encouraging industry to produce and deliver items needed for space projects and users outside. Drawing experts from different centres, the ISRO Technology Transfer Group was formed to help implement policy. The group facilitated a highly successful decentralised system for know-how transfer that met the diverse needs of ISRO from industry. Directly involving developmental teams to interface with industry was one of the success factors in the know-how transfer and in overcoming the problems of absorption of technology. Multi-pronged initiatives resulted in awareness building, quality assurance, selection criteria for industries, know-how pricing principles and innovative contract systems, and so on. ISRO provided buy-back commitments in cases where such technologies mainly catered to the needs of ISRO's projects. A very high level of motivation, dedication and orientation to succeed was witnessed among numerous personnel in various ISRO centres.
2. Cooperative arrangements were evolved with prominent public enterprises such as Bharat Electronics and Hindustan Aeronautics Limited to set up dedicated divisions (Aero Space Division at HAL, Bengaluru) or production lines for space and ground systems that were hailed as a milestone in ISRO industry

collaboration. In time, Indian industry from both private and public sectors had become a partner for production of many complex sub-systems such as satellite structures and other components, control systems of rockets, intricate fuel tanks and associated components, liquid rocket engines and stages, propellants, and a host of special purpose equipment and test facilities.

The Indian Space Research Organisation spearheaded numerous innovations in the field of materials and special chemicals and successfully produced them for industry. This involved collaborative efforts between ISRO, DRDO, other national research laboratories and industry. ISRO made a substantial investment in Mishra Dhatu Nigam (Midhani), which resulted in the development and use of Indian Maraging Steel, the Titanium alloy used for tanks and gas bottles and a variety of Maraging alloys. The collaborative funding and technology transfer to Tata Advanced Materials Ltd (TAML) resulted in the production of high temperature resistant composites. Similar efforts with Godrej & Boyce lead to the creation of special magnetic materials, insulators and materials compatible for cryogenic engines and spurred indigenous developments. The collaborative environment brought about by ISRO in development, scale-up and ultimately realising the processes in industry for application in space systems, is a notable offshoot of a pragmatic self-reliance policy.

A distinct characteristic of the space industry policy nurtured by ISRO during the initial decades of space programmes in India was strong public investments for developing a total range of technologies for peaceful, developmental applications of space and a strong recognition that harmony of government and industry endeavours are crucial for both. It also emphasised the value of long-term commitments that make space and industry partnership viable. This does not seem to have happened in the defence sector.

In order to manage the expanding industry interface tasks of ISRO and help evolve the fragmented space industry in India to the next level of integration, as well as to position Indian space capabilities on a global platform, the Antrix Corporation was established in 1992 as a corporate commercial arm of ISRO. ISRO's anchor for such a commercial entity was initially necessary in order to meet the market's demands and also to mitigate high risks. Antrix relied maximally on infrastructure, facilities and expertise created in ISRO as well as in Indian industry. It made significant progress by forging collaborative relationships with global industries and is trying to create synergies to serve both the domestic and international market.

The Industrial Policy of the Space Commission is a visionary policy that has been supported by focused execution. Similar attempts have been lacking in the defence segment. The following needs to get addressed:

Buy-back Commitments: The DRDO procurement policies could not incorporate this provision as the Services are operating the DPP which starts treating the DRDO developed products afresh for acquisition. This affords limited commitments to development partners. While provision exists in Para 72 of the DPP for the grant of AON (Acceptance of Necessity) for design and development by DRDO, its production vide industry would be as development-cum-production partner

(DCPP), identified during the design and development phase by a transparent process. This option, however, has to necessarily be exercised by the MoD and the Service Headquarters in time. The fact is that this option has not been exercised.

Technology Transfer: The ISRO industrial policy execution has resulted in the existence of Technology Transfer Groups that ensure effective transfer of technology. Such intense systems and processes are yet to take root in the DRDO.

ISRO-funded private industry technology centres should be replicated in the defence sector as many of their technology requirements are unique and are unlikely to find a business model to support these needs without government funding.

3.3 Integrated Guided Missile Development Programme (IGMDP)

3.3.1 Initial Projects

The Defence Research and Development Laboratory (DRDL) as the only missile-centric laboratory suffered from an existential crisis between 1979 and 1982 after the closure of the successful *Devil Project* (indigenisation of SAM 2 surface-to-air missile for the Air Force). The government decided to give it a new lease of life under the leadership of Dr. A.P.J. Abdul Kalam. After he took over in 1982, it was decided to make it a composite programme of five missiles, each of a different class.

1. *Agni* long-range ballistic missile
2. *Prithvi* short-range surface to surface missile
3. *AKASH* medium-range SAM
4. *Trishul* short-range SAM
5. *Nag* fire and forget ATM

The programme with a target of five years for development, was meticulously planned with all necessary empowerment to the DRDO to execute projects in an integrated way with multiple DRDO labs, other institutions and industries, public and private sector. The rest is history. Agni and Prithvi were successfully developed more or less on time, while other projects were dogged by delays, technical problems, failures, partial solutions, user criticisms and cost over-runs. The Trishul was closed. The AKASH, blessed with an outstanding project leader, succeeded after more than 20 years and went into large-scale production. The Nag went through repeated success and failure cycles, and currently after 35 years is in the final stages of user trials.

The lessons/observations gleaned from IGMDP are:

1. AGNI and Prithvi, though larger missiles, were technologically less complex while the other three smaller tactical missiles with high maneuverability were technologically complex.
2. Higher priority is being given to the first two, being more strategic, rewarding and visible. Services also had no import options for them.
3. Failure of the DRDO to develop some crucial sub-systems on time like the **RF (Radio Frequency) seeker for the AKASH and IIR (Imaging Infrared Seeker) seeker** for the Nag. An RF seeker has finally been developed the last couple of years. Luckily, the AKASH has acquired alternate command guidance with some good work on

phased array radar from the LRDE and other institutions. The Nag IIR seeker saw light of day after 20 years of the project start and guided flight trials could start only in the early 2000s.

4. Trishul probably made **wrong guidance** and radar choices, maybe due to non-availability of better ones. The technology gains, however, in many areas of the short-range SAM's development have been substantial and are paying dividends today in other projects.

5. The complex sub-systems of the tactical missiles faced quality and inadequate qualified hardware problems. One of the reasons was frequent **design changes** necessitated by failures.

6. The time frame required for development and production of complex systems which need development of multiple material and other technologies as seen in other countries also **should be planned in a time frame of 15 years or more**.

7. The time frames in which systems were actually realised is not abnormal, considering that even globally the first type of combat systems development has taken 20 to 25 years or more. Subsequent upgrades as Mark II and so on are developed in much lesser time.

3.3.2 Subsequent Missile Projects

1. In the 1990s, the single missile lab DRDL was split into two labs initially, DRDL and RCI and later into three, including ASL for just the AGNI series. This led to divided leadership and divided responsibilities. The tactical missiles left with DRDL suffered from inadequate crucial support from other labs.

2. There was no single programme leader with all resources under his command and capable of deciding priorities.

3. To make matters worse, while older projects continue with production and support responsibilities which rightly the production agency should have taken over as it did not establish strong engineering capabilities to absorb the technologies transferred. **Further in the last few years, at least five to ten missile projects have been added with very ambitious timelines.** Though new projects are also sanctioned with a similar management structure like IGMDP, the ease and effectiveness has come down over the years. Many board and individual powers of projects and labs, though they exist on paper, have been curtailed leading to avoidable delays.

The effectiveness of the Technical Review System that Dr. Kalam introduced has drastically come down over a period of time.

Mitigating factors

1. Though the above points have adversely affected the system, many positive factors have reduced their impact.

2. Much more intelligent and better trained engineers with far better engineering tools are now available.

3. Capability and willingness of industries, large and small, to share the development load and take up production responsibilities with investments.
4. Much better basic technologies in avionics, materials, manufacturing, NDT, software tools and test facilities.
5. Above all, a rich heritage of **knowledge and experience** from our own programmes, **online published knowledge** and availability of capable and willing consultants and joint development partners.
6. **Willingness of Services to commit certain limited production numbers conditionally especially in joint projects. This should become a standard criterion for future projects.**

3.4 AKASH

Earlier called SAM-X, the all-weather, multi-target missile AKASH was an ambitious Medium Range Surface-to-Air Missile (MRSAM) system made to specifications which were nothing less than revolutionary in the 1980s. With an envisaged range of 25 km, the system was built around an indigenously developed advanced phased array radar, a technology available only to a handful of nations. The **AKASH was designed to engage aircraft, helicopters and Unmanned Aerial Vehicles (UAVs).** Two versions were planned, one for the Army and the other for the Air Force. While the DRDO was the main DA (Development Agency), Bharat Electronics Limited (BEL) was identified as the main production agency. Many DRDO labs such as LRDE (Electronics & Radar Development Establishment), ASL (Advanced Systems Laboratory), Defence Research and Development Laboratory (DRDL), Research Centre Imarat (RCI), Research and Development Establishment Engineers (R&DE), and Vehicle Research and Development Establishment (VRDE) were involved with the project. The quest for indigenous SAM technology was carried out in the face of international sanctions that stemmed from the Missile Technology Control Regime (MTCR). Denied even commercially available dual-use components, DRDO scientists had to literally reinvent the wheel.

Trials in 2004 commenced after lot of prodding by HQ DS. The Air Force participated in the trials. All modes as asked for by the user were proven except for very low level coverage. Later, these could not be tested due to non-availability of the target. Trials on the improvised target were accepted and were proven. HQ IDS wanted the LOI (Letter of Intent) to be issued, but this was not agreed to by the user.

After a long and challenging development cycle, the missile system was finally ready for user trials in 2007 and the same process of trials had to be gone through before the issue of LOI.

Thus, it took over 20 years for development as against the envisaged 12 years when the project began. The Air Force trials were successfully completed in December 2007 and two squadrons of the missile system have been inducted into service. However, the Army refused to accept AKASH and carried out its own trials from which it subsequently pulled out stating that the missile does not meet some of the requirements. Rather oddly, the Army did not participate in the Air Force trials even though the only major difference between the Army and Air Force configurations was that of mobility. The Army only accepted to induct the system in 2012 after a prolonged delay.

On one hand, the DRDO has claimed the missile system to be a success with capabilities almost matching the Patriot PAC-3 system. So confident has the DRDO been about the success of the missile system that it has worked out a unique public-private partnership to produce and market the system. On the other hand, the Service HQs, especially the Army, does not seem to share this perception. While the Indian Air Force (IAF) has decided to induct two squadrons, it is no secret that it required a fair amount of 'prodding' before doing so. The same has been the case with the Army. Meanwhile, many other countries have expressed their interest in the system. **In order to draw meaningful lessons, the progress of the project was mapped onto the classical 'Technology Development Life Cycle' which raised some pertinent, and at times, uncomfortable questions.** The project development has been as follows:

Stage 1 Requirement Analysis and Definition

Stage 2 Concept Design and Realisation

Stage 3 Concept Testing and Validation

Stage 4 Production

Stage 5 Logistics and Service Support

Stage 6 New Idea (Concept Improvement)

Lessons learnt along with graphic model are summarised in succeeding paragraphs.

3.4.1 Lessons Learnt from Project AKASH

On evaluation of the case study, the lessons learnt from the AKASH project are as follows:

1. To ensure that focus on indigenisation is maintained by all stakeholders, the DRDO should project the need for strategic value systems, have successful game changing projects at regular intervals and strive for appropriate changes in the defence acquisition and procurement system. There is a need to maintain much closer interaction between the DRDO and users through all stages of project development and exploitation. Without this **continuous interaction**, it either dies or at best remains static.
2. Promote success of projects once they are productionised to show case advantage over former import systems. In this projection, DPSUs and private industry, together with the user, need to play a leading role. This is necessary **to develop our export potential.**
3. **Project definition document needs to be more comprehensive.** It should also bring out likely bottlenecks in the development path, depending upon the complexity and technology availability as also the user operational needs in view.
4. There is a need **for a more flexible time frame and cost estimates** for projects involving new and critical technologies.
5. Project development phases should follow a spiral and incremental technology **development cycle as**

is being done in other major arms producing countries. User should be sensitised at the beginning that Mark-I may have only key features. The desirable parameters will get incorporated in the follow up versions, similar to the US Patriot Missile versions.

6. Bureaucratic and ponderous decision making organisations and processes need to be done away with. There is a clear requirement of organisational restructuring with greater devolution of financial and functional autonomy for the DRDO. The Rama Rao Committee's recommendations should be implemented at the earliest. In addition, where a composite team is formed involving scientists from different labs and later on from DPSUs and private industry, clear lines of authority and accountability need to be drawn up. Had decision making been swift, Trailer Mounted version of AKASH for the Air Force would have preempted subsequent difficulties.

7. Decision to mount the system initially on BMP and then onto T-72 tank, brings out the need for a more in-depth technology study and forecasting to avoid mid-course corrections. Greater user involvement too, becomes essential.

8. In long drawn out projects like AKASH, changes in the GSQR need to be anticipated to address user concerns regarding technological obsolescence in a fast changing technology regime.

9. Preparation of equipment and execution of trials need to be planned in far greater detail, jointly with the user. This was evident in all trials like EW, functionality, mobility etc. The user has to physically operate the equipment and attain optimal performance out of it. He cannot be expected to be satisfied with simulation results, wherever field trials are feasible and affordable they should be conducted

10. In order to ensure the success of the Bring into Being Strategic Projects like AKASH, the Arjun Tank or Project AD, prior hype and overstating the success of various sub-systems/phases needs to be curbed until field trials have demonstrably succeeded. Premature publicity also activates inimical interest groups (competing commercial, hostile adversaries etc.) to delay/abort the projects through various stratagems/intrigues ranging from technology denial, diplomatic pressure, financial complications or media manipulation. These aspects have to be part of a policy jointly evolved with HQ IDS and MEA. Users too need to be sensitised and made to realise the fact that a strategic capability when successfully fielded and fully matured, will not only meet their current operational requirement, but also provide an indigenous continuum for future transformation.

11. Collaborations like '*Brahmos*' following a consortium approach are models for enhancing indigenous capacity provided technology transfer encompasses IPR, material, design and complete production technology as also the processes.

12. A final say on success **or rejection of strategic value systems should not be solely determined by the user.** There is a need for an independent authority like the **Defence Technology Commission** to recommend the best course of action to the COSC/DAC/Government.

13. Overall model is at figure I.

3.5 Light Combat Aircraft (LCA)

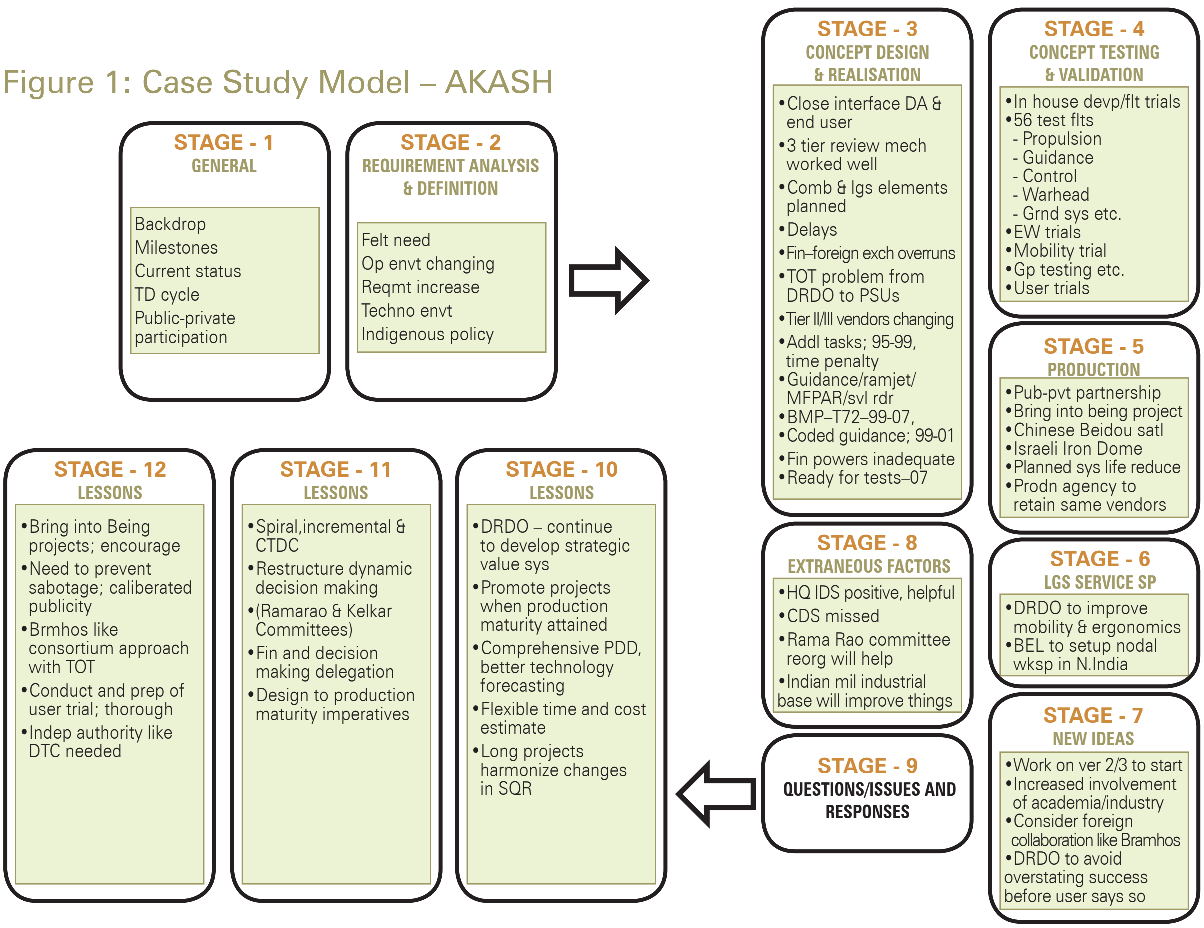
The Light Combat Aircraft (LCA), unlike what is reported in the press, is a success story with several lessons for our defence planning. Project management and production systems have emerged out of it.

In 1983, a Project Definition Study was ordered and **project sanction came for it in 1993,** wherein only 60 percent of the amount requested was given with a mandate to develop **only two non-weaponised technology demonstrators.** The balance amount was sanctioned only in 2001 after the first Technology Demonstrator was flown successfully. The Air Force and the MoD were major players in these approvals.

1. **At USD 1.2 billion,** the costs incurred are of an order of magnitude lower than what has been incurred elsewhere. **Time overrun is marginal and compares favorably with complex aircraft or systems developed the world over.**

2. Performance-wise, even with the **GE 404 engine,** the LCA has shown itself to be superior to the **MIG-21 BIS** and in many critical parameters even to the **Mirage 2000.**

Figure 1: Case Study Model – AKASH



3. The LCA is a fourth generation plus aircraft with full networking capabilities. It is most suitable for network-centric warfare, where indigenous systems for secrecy, security and interoperability are a must for mission success. Imported systems cannot meet these requirements.

3.5.1 Current Status

Hindustan Aeronautics Limited (HAL) has handed over **10 indigenously produced Tejas aircraft** to the Indian Air Force and has firm orders to produce **40 aircraft. In addition 83 more LCA Mark 1-A have been committed by the Indian Air Force (IAF) for production by HAL.** Production is being scaled up to 16 aircraft per annum through a wide range of measures now initiated.

3.5.2 Evaluation

There have been several articles in the press and notes from the Services which are critical of DRDO projects in general, and specifically, the programme related to the LCA now named **Tejas and IGDMP**. It is important to put the real facts relating to these programmes in perspective on crucial issues of time and cost overruns and performance shortfalls. It may be mentioned that what is **most relevant today is an assessment of the capability developed** in relation to the requirements of the mission need, and not just staff requirements based on which projects are initiated, as these are quite often just the best of 'Brochure Claims' not achievable either domestically or through imports. Based on well-known facts and performance parameters, now well-documented, the following aspects clearly emerge in respect of the LCA:

1. The start time of the **LCA project sanction is 1993** and not 1983 when essentially only a Project Definition Study was ordered. In considering the development time further, we must take note of the nature of project sanction in 1993, wherein **only 60 percent** of the amount requested was given with a mandate to develop only **two technology demonstrators** (weaponisation and operational clearance was to be subsequently initiated).
2. The balance amount was sanctioned only in 2001 after the first **technology demonstrator was flown successfully.** The Air Force and MoD were major players in these approvals and it seemed there was a need for better technical appreciation of the development programme and risks enunciated in the project development document by all stakeholders.
3. When considering aspects of performance achieved, it would be necessary to compare it with the figures in the Project Definition Document and not the initial ASR figures in the 1983 CCPA paper, as these were to be refined with the Project Definition Studies and discussions with the Air Force. This aspect was also noted in the CCPA sanction.
4. Keeping the above in mind, it can be inferred that **there has been no cost overrun. As a matter of fact, there have been cost savings, as two additional prototypes were built**

within the sanctioned cost. At USD 1.2 billion, the costs incurred are an order of magnitude lower than what has been incurred elsewhere. Also the time overrun is marginal – at best a year or two and compares favorably with complex aircraft or systems development times the world over.

5. Engine development, it is true, requires further effort, and the GE404 engine, which also powers **the F18 fighter** bomber, has been used to power **the LCA.** The costs incurred to date are again much lower than what has been expended elsewhere. For example, even SNECMA, the sole fighter aircraft engine manufacturer in France, despite decades of experience in developing and manufacturing engines for Mirage III, V and F1, **took about a decade and USD 2.2 billion to develop the M88 engine.** *Kaveri,* which is GTREs and the nation's maiden effort, is unlikely to exceed USD 1 billion even after the joint venture development effort now proposed.

6. As regards performance, the following emerges:

   i. The LCA with GE404 engine has done over 3,000 hours of flight testing remarkably smoothly. Even with that engine, the performance has been not only vastly superior to that of even the recently upgraded MIG 21 BIS (the IAF is operating 400 of the series), but it has shown itself to be comparable on many critical parameters to the Mirage 2000. Modifications to the aircraft structure are underway to reduce weight, improve the engine and aerodynamic performance. When the GTRE's proposed JV with a leading foreign engine manufacturer is completed in about four years, the Kaveri will be brought to a performance level superior to the GE404. Fitted with it, the LCA will be truly comparable to the Mirage 2000, and in many respects, even superior. And, all this in an aircraft that is much lighter and has technology far superior to the Mirage 2000

   ii. In generational terms, the LCA is a fourth generation-plus aircraft with full networking capabilities, and with the R73, which is the most potent air-to-air missile in our region, the LCA has better technology (digital fly by wire system, advanced composites, fully digital cockpit etc.) than any other aircraft in the IAF inventory.

   iii. Further, considering that warfare has shifted to a **Network Centric dimension from a Platform Centric one,** these capabilities in the LCA makes it truly formidable. Network Centric Capabilities require intrinsically indigenous systems for secrecy, security and interoperability. It is a fallacy to think that we can continue with our importing spree and still have a secure and interoperable network centric capability. This aspect applies practically to the entire ICT infrastructure of the armed forces and the introduction of technologies like the Software Defined Radio makes the issue even more critical.

7. Finally, as recently as in 2004/2005, the **IAF's requirements before the Defence Procurement Board for 126 new aircraft was** essentially for only an upgraded Mirage 2000 (whose upgrade is again sought). It was argued that as far as aerodynamic performance was concerned, the Mirage 2000 represented the achievable limits for the class and met the threat perception. This aircraft was sought to be purchased as a cost-effective option on a single tender basis. The RFP (Request for proposal) now issued seems to be very broad-based and emphasises more on 4th generation technologies so that the full spectrum of fighters from the light weight GRIPEN to the heavier twin engine F-18 and MIG 35 are all in the race and the Mirage 2000 would be separately upgraded to these technologies. The fact is that all of these technologies are available in the LCA (avionics package, digital quadruple FBW, Elta (and later developed AESA radar [under active trials today]), which are equivalent/ better than the Gripen. The current **MIG 35 is nothing more than a single demonstrator, not even close to a possible production version.** It is clear that **the LCA is a highly cost-effective fighter** for volume induction in the IAF. **The lexicon of the LCA,** MMRCA etc., seems unrealistic – of relevance is capability needed to meet Mission Needs in relation to our threat perceptions taking note of the assets available (SU30 etc.).

It is clear from the above, that there are issues that need to be examined at the highest level **before negotiating any more multi-billion dollar aircraft purchases and upgrades.** Of importance is the necessity to build capability that meets our **Mission Needs** in relation to our **threat perceptions** and not just detailed technical specification embodied in our ASR. Importing capability off the shelf or through TOT (which in fact is ONLY LICENSE MANUFACTURE) for the Armed Forces across the board (even where indigenous capability is viable especially in the context of our threat perception (like Chinese JF17/J10) is unlikely to be economically feasible, and would only increase our dependence and constrict our foreign policy choices while giving us a capability that will be highly vulnerable in a **network centric and information warfare environment.**

The LCA is in a strong position to meet the requirements of the Indian Air Force and also has substantial potential for export.

3.6 Strategic Sub-surface Platform

3.6.1 Programme

The Strategic Submarine project is a three decade pursuit of a survivable nuclear launch option. It owes its genesis to events of the 1971 war that proved the efficacy of submarines as a great deterrent to adversaries far exceeding one's own defence capability. Post the peaceful nuclear tests of 1974, the political leadership accorded a go ahead for feasibility studies. It brought together nuclear scientists of BARC, weapon and system engineering experts of DRDO and the Navy as also their ship designers, to lay the foundation of a fruitful partnership that culminated in this successful programme. **A robust programme management organisation** and steering at the top most echelons of government (regardless of regime changes, sanctions or budget constraints) allowed the programme to operate under the radar for a considerable period. When the cover of secrecy was finally blown, the programme was well on its way to realisation. In a country that swears by the 'no first use' nuclear doctrine, it could not have come a day sooner. This should be the standard practice for all system-level programmes in the country.

What they got right

The programme got a few things right though, for example:

1. Top leadership support that made for continuous flow of funds.
2. Bringing together the departments of Defence and Atomic Energy in a robust programme management organisation that allowed for smooth coordination, pooling of resources and result-orientation without undue acrimony.
3. Secrecy that saved it from too much scrutiny/pressure from media, interim milestones, and if one may dare say, financial audits.
4. The biggest success of this programme would undoubtedly be encouraging a host of private sector big players (L&T, Tata, and Godrej etc.) to wholeheartedly support this endeavor despite restrictions of government secrecy, lack of clarity on future business potential and technical risks.

3.6.2 Indigenous Eco-system

1. Surprisingly, they did so with minimal/ negligible deviations from standard DRDO procurement manuals. Only deviations were in the area of tendering (most are limited tenders with absolutely nothing on open tender/e-procurement route), flexibility in awarding advance and control on waivers/extensions and contract management. However, the above was considerably facilitated by the fact that this was a top secret project and the processing of cases, financial and otherwise, essentially happened at the joint secretary level and above.
2. The programme invested significant efforts in qualifications of vendors and building a supplier base. Once a bidder was selected for award of contract, the programme team managed the relationship in 'development partner' mode rather than in 'buyer-supplier/vendor' mode. A development partner could rely on tapping the programmes considerable internal expertise, documentation, organisational knowledge-base and testing/integration infrastructure. In fact the programme made the success of their development and production partners as their own business, as the failure of any partner would ultimately be a setback to the programme itself.
3. For a few critical projects, they also went beyond the call of strict contract by way of expanding scope and funds, especially if these delivered better results in quicker time. The Programme leadership fully utilised institutes of national repute through academic/research engagements. These gainful engagements were also available to their development partners on need basis, without delays in the approval of their proposals.

3.6.3 HR Practices

As the apex organisation is led by naval officers, staffing of adequate naval officers has been well handled. One surprising phenomenon is that the programme team generally comprised of 'passed over' officers. Though this lot is treated with trepidation by the armed forces hierarchy, the programme has made use of their technical expertise, professional ego, locational immobility and willingness to give to the nation, in a most positive way. This can be a role model for a variety of R&D organisations that keep citing 'lack of user involvement' as a major constraint. Further a considerable continuity of personnel involved in the project was ensured.

3.6.4 Sanctions Regime as a positive force-multiplier

One of the biggest advantages of the programme (shared with the IGMDP), was that the project had no competition as users could not opt for acquisition by import route, nor could foreign entities strategise to interfere with their programmes. Second, this being a first of a kind work, failures could be condoned and they did not have to fear the Damocles Sword of go/no go decision at every milestone. Third, the sanctions regime ensured that the indigenous route was almost always the first and only option. The team was well-imbibed with the spirit of pioneers and could enthuse its vast array of industry partners (both from the private and public sector), advisors from academia and foreign collaborators (there were a few, especially at the start). It should be clear to the nation that if sovereignty as a pillar of foreign policy is to be preserved and affordability of systems ensured, Make in India, through indigenous R&D, will be a necessary condition.

3.6.5 Areas of Improvement

1. Due to the secretive nature of the programme and constraints of foreign assistance, the programme has many imported systems in the first boat. Obviously, they must have been taken as a 'cost' of foreign assistance and as internal expertise has built up, one can see considerable improvements in the indigenous content. It is understood that the team is aiming for near 100 percent indigenisation in the next set of submarines on order.
2. Strategic boats being relatively 'noisy' programme could have done with widespread use of CAE (computer aided engineering) for reduction in noise levels by improvements in vibration analysis, multibody dynamics, CFD (computational fluid dynamics), thermal management, space optimisation etc. It may be noted that CAE and High Performance Computing has been a key applied engineering area in strategic submarine design the world over. Given the world leading expertise of Indian IT/engineering services companies in this space, minimal exploitation of CAE and HPC is surprising.
3. The programme developed a host of suppliers by spending public money. These projects delivered successful products that are qualified and used onboard strategic platforms. However, the navy continues to maintain a hands-off approach to this vendor list and regrettably imports a lot of items where equivalent indigenous products have been developed.

Chapter 4: Arriving at the Capability Needs – Evolving LTIPP and Beyond

4.1 Evolving LTIPP through Strategic Guidance

As stated earlier, the development of indigenous systems requires time for realising the technologies required, establishing adequate critical facilities and integrating the same into systems. Thereafter, time is required for various trials and evaluations and its production and induction into service. This time frame could be anything between 10-15 years and beyond, depending upon the complexity of the system and the nation's technology readiness to develop a particular system.

The DPP 2016 enunciates (Paragraph 16 of Chapter II) that proposals for acquisition of capital assets flow from the defence procurement planning process, which will cover the long, medium and short-term perspective (LTIPP, FYAP and AAP). Under Design and Development Cases, SHQs will initiate SoCs for Design and Development cases from LTIPP/FYAP/AAP in consultation with DRDO/DPSUs/OFB (Para 72(a) of Chapter II). However, it will be clear that the FYAP and AAP does not provide the required time for development and production of indigenous systems. The LTIPP, therefore, is the fountainhead from which the military weapon systems requirements emanate, and hence, is the basic document for the development of technologies and systems indigenously.

In the sphere of defence planning, the study observes that the main lacunae lies in the **lack of integrated guidance documents** which would enable **evolution of the LTIPP** as a capability and security investment programme for the next 15-20 years from which each of the services could draw their schemes/project programmes on long-term basis.

The starting point in the process of formulating an LTIPP is the **articulation of strategic guidance.** The salience is flagged in succeeding paragraphs.

In the increasingly complex and interdependent imperatives of a modern nation state, defence/security planning dimensions are required to be processed through an integrated system comprising of security concept, national security strategy (NSS), defence/military strategy, strategic defence review, Raksha Mantri's (RM) defence planning guidelines, defence capability strategy, technology development strategy/plan. It may be mentioned that the RM's operational guidance document is inefficient for the purpose.

From LTIPP, each of the services will draw their schemes/programmes and projects on a long-term basis and submit the same for approval. Such a plan will lead to **Integrated Force Development Guidelines** (IFDG). In parallel and in sync, the **Long Term Technology and System Development Plan** (LTTP) needs to be evolved. The scientific establishment needs to be deeply involved in this process and their inputs could even in some cases alter the contours of the LTIPP.

The IFDG needs to be prepared and should serve as an integrated guidance document for capability, technology and budgetary estimates. Its components are as follows:

1. **Strategic Posture Guidance (SPG).** Strategic and operational scenarios should be developed from the strategic guidance documents, SPG, interests, goals and objectives and their impact and likely responses from adversaries/competitors.
2. **Joint Concepts/Doctrines.** Related to the strategic futures, these should visualise future operations and describe how forces might employ capabilities necessary to meet future military challenges for a period from 10 to 15 years.
3. **Science and Technology Strategy.** Technology Development Strategy needs to cover basic, applied and advanced fields of research, development and production.
4. **Evolving Costing Mechanism.** Defence Financial Forecast Plan will require drafts of the LTIPP and LTTP to be co-developed in an integrated manner.

These two documents (IFDG and LTTP) will encompass joint capabilities as also service-wise capabilities of the individual services. The latter will be developed by each service and coordinated by the HQ IDS in sync with joint capabilities strategy.

The system of generating **strategic guidance** in the form of national security/defence/military strategies, strategic defence review (SDR) and RM's planning guidelines **is not institutionalised in India.** While in all the major foreign countries, it forms the foundation of future force development system. As this is of crucial importance, it will be analysed in detail as a **separate** paper wherein following aspects relevant to creation of technology and system capability will be considered.

1. **Material technology creation system,** (where material is used as a generic term for equipment, weapon or information system and technology creation implies translating capabilities set out by the planning process into technologies, their successful application to produce systems/weapon platforms at affordable cost and in given time frame).
2. **Technology research needs and opportunities exploration.** (It will define the technology availability as relevant to the LTIPP and the gap areas for further exploring the opportunities to plug the gap). The framework for leveraging the technology readiness available is flagged as given below:
   i. Technology development is the process of developing and demonstrating new or unproven technology as also the application of existing technology to new or different uses, or the combination of existing and proven technology to achieve a specific goal. Technology development associated with a specific acquisition project must be identified early in the project life cycle and its maturity level should have evolved to a confidence level that allows the project to establish a credible technical scope, schedule and cost baseline.

ii. Projects that perform concurrent technology development and design implementation run the risk of proceeding with a poorly defined project baseline. In the USA, considerable research has been done on various aspects of management of technology. Particularly, NASA (National Aeronautics and Space Administration) and DoD (Department of Defense, USA) have adapted models that will assist in identifying elements and processes of technology development which are required to reach proven maturity levels to ensure project success. The nine stages **Technology Readiness Levels** (TRL) has been an effective tool for adaption of this model.

iii. Rational measurement of indigenisation is a much needed input for the decision makers involved with acquisition. TRL clearly illustrates that the **ToT is confined to TRL-9 and partly at best to TRL-8.** Consequently, the earlier TRLs remain opaque to the recipient forever. The technology maturity process in India is beset with many other dimensions that the USA does not suffer from. Technology enablement through **Transfer of Technology** (ToT) is highly prevalent in many segments and particularly with defence and other advanced technologies. The technology obtained through ToT needs to be indigenised progressively in critical areas. If the technology is home grown, then the production agency has opportunities to get involved in earlier TRL stages, taking the knowledge accrual from know-how to know-why. This know-why is essential for bringing about the inevitable upgradation and hedging against any supply chain risks during the lifetime of the system.

4.2 Material Acquisition: Analysis and Decision Mechanism (Defence Production and Procurement System)

At this stage approved user needs should have been listed out as also the long-term technology perspective/strategy provided, listing the technology resources and opportunities available within the country and outside. This will lead to decisions on programmes and projects to be taken up to fulfill the requirements of the LTIPP and the **Defence Procurement and Production Strategy (DPPS)** evolved.

4.3 Defence Procurement Policy/Procedure

Relevant to this study, it is assessed that with the capabilities built up in the country as a result of projects that have been taken up (successful or otherwise), it should be possible to meet many of our requirements through the Make process. And the intent must be to maximise our inductions through IDDM route. Where Buy/Buy and Make is still resorted to, it should be our objective to procure minimum numbers necessary to meet our short-term requirements, allowing time to enable IDDM route to be plugged in.

Figure 2: Framework for technology development

Stages of Design and Technology Readiness

Technology Readiness Level	Design Stages	Time Period (Years)	"MADE IN INDIA"	"MAKE IN INDIA"
9	Sealed design particulars	3 (Production Stage)	Know How	Know How (Limited to Tooling & Manufacturing Drawings/Specifications)
8	Manufacturing & tooling design			
7	Qualification design			May or may not be made available by Foreign Company
6	Final prototype design	12 (R,D&T Stage)	Know Why Remains in India & Adds Value to National Security	Remains with Foreign Company Hence a Vulnerability to National Security
5	Early prototype design			
4	Detailed engineering design			
3	Preliminary engineering design			
2	Concept design			
1	Sketch design			

**Made in India indicates Make in India through IDDM route while Make in India is indicative of acquisition through Buy and Make category.

4.4 TPCR

With the process now explained TPCR may not be necessary to issue as the projects and programmes that emanate from the LTTP will serve as specific requirements for capability development to the industry on a long-term basis. Confidentiality where relevant can be tackled as has been done in ATV, LCA and other projects.

4.5 Requirement Specifications

In the present acquisition process, we use the term Qualitative Requirement to describe the end-to-end process of identifying the military requirement and finalising the document that is included in RFP. However, the sub-steps involved are:

1. **Operational Requirement:** Purely that of the domain of military. At the time of formulation of programmes /projects, these requirements would essentially take the form of concept of operations (con-ops) in which the system will be employed.
2. **Functional Requirement:** Military and System Design community.
3. **Engineering Specifications:** Evolved by System Engineering community with awareness of Technology Readiness Levels and Manufacturing Readiness Levels.
4. **Material Specifications:** Specialists domain.
5. **Requirement Specifications:** An all-encompassing document that will emerge in its totality with the culmination of the project definition phase. However, these need to be kept flexible in the case of indigenous design and development falling under the scope of IDDM, whereas in the Buy and Buy and Make case these requirements must be rigid as the

acquisition of a fully developed and operational system.

6. As we do not use this vocabulary/ terminology in our acquisition documents, the QR that is evolved is entirely managed by the Services. It is recommended that:
   - i. Operational Requirement be evolved by the Services.
   - ii. All the other steps leading to total requirement specifications must be evolved by experts from DRDO and Industry for IDDM projects.
   - iii. This document must establish all essential linkages with the Operational Requirement to the entire satisfaction of the Services.

4.6 Modelling and Simulation

Modelling and simulations need to be used in different forms for different levels of decision making, for example at the national security strategy level, these tools will be used to develop different scenarios and make a judgement to enable determining the preferred option. At another level, that of military and operational strategy, modelling and simulation tools would be useful for evaluating and defining strategic options. At the force and technology development levels too, the tools of modelling and simulation have matured over the years. It is possible to virtually build systems which are near to the real system and to subject them to virtual tests and analysis. With ICT hardware and electronics industry maturing in terms of reliability and 'performance specifications', military systems design engineering is moving away from pre-eminence of hardware design (issues like environment specifications, EMI/ EMC, computing power, memory capacity etc.) to accretion of key features by way of embedded engineering firmware and pure play software. Tools of military designers have undergone a sea change in the last decade or two with product life cycles (including development and testing) shortening significantly. The rise of algorithmic content, complex software and data-based decision-making is leading to the growing use of simulation and modelling in military systems engineering. A few of the biggest gains of this approach are listed in succeeding paragraphs.

1. Mathematical modelling allows for formal notification of equipment/ system behaviour under different scenarios. It is especially useful in visualisation of user requirements and can help in formulation of realistic QRs.
2. It improves testability by defining operational boundary conditions at the very start and allows a designer to validate many engineering options at pre-production stage itself.
3. Models are easier and cheaper to test in lab, thereby reducing need for tooling and production of many 'design samples'. It shortens the development cycle.
4. Powerful computers and new generation visualisation tools allow for fast simulations and computations. Simulations can also be extended to imponderables such as troop behaviour and probable enemy action. Such capability exists in the country.
5. Simulation and modelling tools have been used by leading aerospace and defence LSIs for gaming of threat

perceptions, assessing optimum deployment of weapons and general solution of CEC scenarios.

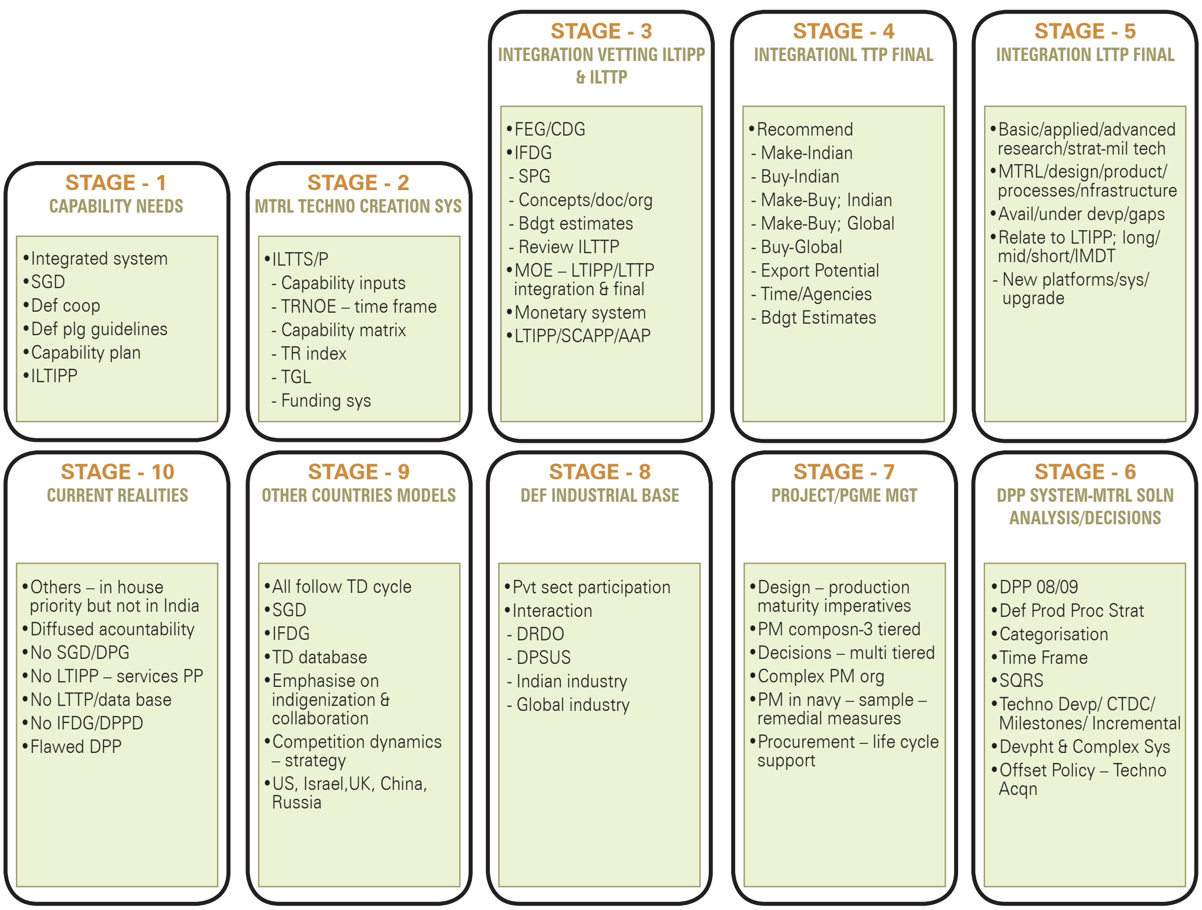
The NCO simulation setup can form a good visualisation centre for all such projects where users could test NCW doctrines, efficacy of CEC procedures, inter-operability of communication protocols, training of crews in tactical symbology etc. NCO simulation centre can also act as an effective strategic war gaming centre where its integrated situational awareness picture and virtual reality/augmented reality tools could be used for briefing/debriefing higher national leadership not very well versed with military lexicon.

4.7 Current Status

Considerable capacity and capability has been created in the country over the last five decades to indigenously develop major complex systems required by the armed forces. This capability and capacity must now be put to full use urgently to ensure that gains painstakingly made against numerous odds are not frittered away due to their non-utilisation. For this and other reasons brought out above, **Make in India programmes and projects executed through the process of indigenous research and development are an urgent need.**

The conceptual framework model is at figure 3.

Figure 3: Conceptual Framework



Chapter 5: Gap Areas and Interim Recommendations

5.1 Gap Areas

The gap areas that have emerged in the current process are as follows:

1. The entire chain of **guidance documents** governing the indigenous technology development and production process and provisions in the defence procurement procedures and procurement manual ultimately leads to our resorting to Request for Information (RFI) and Request for Proposal (RFPs) for foreign procurement.
2. **Strategic documents needed** to arrive at the LTIPP need to be **institutionalised.** This would also require substantial changes in the existing defence planning process.
3. The **15 year LTIPP in its present form provides inadequate guidance** for the purpose of planning for indigenous design, development and production. At present, it is merely a collation of **wish lists** of procurements planned by the Armed Forces. Based on our discussions on the essential process required to arrive at the LTIPP, R&D/industry/organisations can formulate meaningful **Technology and Production Capability Development Plans** and follow it up with effectual development process.
4. Major gap areas in our present procurement process including those stated below will be addressed in a separate report: Issues in development of technologies through fundamental and applied research as applicable. Prototype development cannot currently commence unless PSQRs are released well in advance. Much of the delay occurs due to the absence of PSQRs/QRs, which are generally finalised by the time AONs are accepted. Therefore, AONs must be released well in time for the development, production and processes to bear the fruit. There are also other issues at this stage such as financial and nomination issues, conduct of trials leading to user acceptance and so on.
   1. The industry has failed to productionise domestically developed prototypes to the scale and quality required in many cases. As a result domestically developed equipment that has qualified after intense user trials often fails to meet required standards post-production. Thus, scaling up of production to meet the armed forces requirement becomes difficult.
   2. Lack of a system to encapsulate the positive lessons learnt from successful projects.

iii. The relationship between the users and the developers in the system is more that of buyer-seller. The need to treat the developer as a partner in capacity development is acutely felt.

5.2 Recommendations

Reform the Defence Planning Process, restructure the higher defence organisation and institutionalise the system of generating strategic guidance documents to evolve a meaningful LTIPP and LTTP which alone can form the basis for developing the required programmes and projects resulting in indigenous defence capability.

5.3 Programme Management in Strategic Sphere vs. Conventional Sphere

1. It is seen that sensitive programmes managed in the strategic sphere are executed with synergy to focus on the indigenous effort. The technical and financial decision-making processes are effective and timely.
2. In the conventional sphere, procedures are cumbersome and decision-making is slow. Conventional programmes also have high strategic value to create the required deterrence. There is, therefore, an urgent need to bring the intensity of focus practiced in strategic programmes to be applied to key indigenous defence programmes.

5.4 Programmes and Technologies as part of LTIPP

1. LTTPP (Long Term Technology Perspective Plan) must include programmes and constituent technologies that need to be developed and owned by the country. Development of these technologies and infrastructure creation must be funded as a Programme element ahead of the project sanctioned as is now practiced by ISRO.
2. Developing the LTIPP and the concomitant LTTPP as discussed in this report will necessarily take time to implement. The study group is therefore of the opinion that the following programmes be launched in view of their criticality and the R&D capabilities built up in the country over the last three to four decades.
   - i. Conventional submarine and nuclear attack submarine.
   - ii. Hypersonic missile systems.
   - iii. Integrated Ballistic and Cruise Missile System.
   - iv. Aviation programmes:
     - a. Fifth generation manned fighter technology.
     - b. Development of gas turbines for various platforms under development.
     - c. Development of transport aircraft to meet civil and military requirements.
     - d. Development of surveillance systems.
   - v. AI enabled autonomous systems (Land, Air and Sea) to include platforms like unmanned combat aircraft, unmanned ASW surface vessels.

vi. Cyber security systems for the Armed Forces (Preference only to indigenous solutions, as notified on 2 Jul 2018 Public Procurement [Preference to Make in India] Order 2018 for Cyber Security Products issued by Ministry of Electronics and Information Technology).

vii. Programmes to establish electronic and photonic components industry.

viii. Development of sensors and seekers for multiple users.

ix The raw materials required for production of critical materials both metallic and non-metallic, composites and functional materials need to be harnessed and developed. The present efforts are totally inadequate and a national effort is required in this direction. In case of rare earth, a national implementation plan covering minerals, metals, alloys and downstream products is the urgent need for our self-reliance goals.

5.5 Evolving Requirement Specifications

It is recommended;

1. Operational requirement be evolved by the Services.
2. All other steps leading to Total Requirement Specifications must be evolved by experts from DRDO and industry. This document must establish all the essential linkages with the Operational Requirement for the complete satisfaction of the Services.
3. Total Requirement Specifications must be reasonably rigid for Buy Class of categorisation, but also reasonably flexible for Indigenous Design, Development Class of categorisation.

5.6 Modelling and Simulation

Modelling and simulation should be deployed at all levels of decision making and for system specification and development.

5.7 Model of Space Commission

The Industrial Policy of the Space Commission is a visionary policy that has been supported by focused execution. Similar attempts have been lacking in the defence segment. The following needs to be addressed:

1. Buy-back Commitments: The DRDO procurement policies could not incorporate this provision as the Defence Forces are operating the DPP which starts treating the DRDO developed products afresh for acquisition and affords limited commitments to development partners. Provisions in Para 72(a) of the DPP which could remedy the situation have not been used for various reasons.
2. The ISRO industrial policy execution created fervent Technology Transfer Groups that functioned in the premises of industries to ensure effective transfer of technology. Such intense systems are yet to take root in DRDO.
3. ISRO funded many private industry technology centres which model needs to be replicated in the defence sector as well.

5.8 e-Procurement

The Manual for Procurement of Goods 2017 issued by Government of India Ministry of Finance, Department of Expenditure states in Para 4.15 pertaining to Electronic Procurement (e-Procurement) as follows: "It is mandatory for Ministries/Departments to receive all bids through e-Procurement portals in respect of all procurements. ……... In individual cases where national security and strategic considerations demands confidentiality, Ministries/Departments may exempt such cases from e-Procurement after seeking approval of concerned Secretary and with concurrence of Financial Advisers. …….. (Rule 160 of GFR 2017)". This exemption must be invoked for procurements done by DRDO to enable them to maintain the required secrecy.

This exemption must also be applied to all the DPSUs and Ordnance Factories, and other public sector entities involved in procuring sensitive items.

5.9 Conclusion

This report highlights the very critical need of increasing our quotient of self-reliance for defence systems to achieve both defence preparedness and national security goals. The report hypothesises that this requires overhauling the manner in which armed forces needs are projected to domestic R&D and industry and the manner in which the procurement system thereafter meets the requirements set. The current report analyses and recommends a model for developing a long-term integrated perspective plan as a security investment programme for the next 15-20 years from which each of the services could draw their schemes/programmes/projects on long-term basis. The issues in the procurement system in meeting the requirements set, will be addressed in a separate report.

As creation of such a system for developing the LTIPP and concomitant LTTPP – as discussed in this report – will necessarily take time to implement, the study group therefore recommends that the **Programmes and Technologies** as stated above be launched in view of their criticality, and existence of good R&D capabilities that have been built up in the country over the last three to four decades.

About the VIVEKANANDA INTERNATIONAL FOUNDATION

The Vivekananda International Foundation is an independent non-partisan institution that conducts research and analysis on domestic and international issues, and offers a platform for dialogue and conflict resolution. Some of India's leading practitioners from the fields of security, military, diplomacy, government, academia and media have come together to generate ideas and stimulate action on national security issues.

The defining feature of VIF lies in its provision of core institutional support which enables the organisation to be flexible in its approach and proactive in changing circumstances, with a long-term focus on India's strategic, developmental and civilisational interests. The VIF aims to channelise fresh insights and decades of experience harnessed from its faculty into fostering actionable ideas for the nation's stakeholders.

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