Necessity of System-Integration Approach
Sustaining Atmanirbharta in Defence Projects

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The 'Atmanirbhar Bharat Abhiyaan' or 'Self-Reliant India' campaign was launched by Prime Minister Narendra Modi to make the citizens of India self-reliant in all aspects. In May 2020, a package of Rs 20,00,000 crores (US$ 262 billion) was announced to provide policy and financial support to micro, small and medium enterprises (MSMEs) and cottage industries of India.

India is one of the largest arms importers in the world accounting for 11 per cent of the total arms sales globally. It is widely acknowledged that self-reliance in the defence sector is the most important constituent of 'Atmanirbharta'. To become an economic superpower, India must achieve self-reliance in the production of defence equipment. 'Atmanirbhar Bharat Abhiyan' is expected to help India achieve self-reliance in defence manufacturing.

Historically, defence manufacturing has been the preserve of Ordnance Factories and Defence Public Sector Undertakings (DPSUs). The participation of the private sector was restricted due to lack of access to advanced defence technologies and complex security and licensing norms.

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ISSN 0976-1004 (print); 2583-7567 (online)

Journal of Defence Studies, Vol. 18, No. 3, July–September 2024, pp. 216–227

'Atmanirbhar Bharat' aims to bring the private sector into defence research and development (R&D), manufacturing and production. It is anticipated that private sector participation in defence will encourage foreign producers to form strategic partnerships with various Indian businesses. This strategic collaboration will enhance participation of the Indian private sector companies in the unexplored defence sector of India and generate numerous opportunities for them.

The Union Budget 2022–23 has added momentum to atmanirbharta in defence. The budget has depicted India's true efforts to achieve self-reliance in the defence sector. Around 70 per cent of the defence budget has been reserved for the domestic defence industry. Contracts worth Rs 54,000 crores (US$ 7.1 billion) have been signed for domestic procurement. Furthermore, the country's arms exports stood at Rs 11,607 crores (US$ 1.5 billion) during FY 2021–22, a substantial increase compared to 2014. This surge was attributed to several reforms proposed by the government to scale up defence exports and enhance the ease of doing business. The government aims to achieve an export target of Rs 36,500 crores (US$ 4.8 billion) by 2025.

The 'Make in India' movement has been effective in supplying various equipment, which is being used extensively by the armed forces of India. From 2018 to 2021, the Government of India granted Acceptance of Necessity to over 150 proposals worth Rs 2,47,515 crores (US$ 32.4 billion) under various categories of capital procurement, which is expected to enhance local manufacturing as per the Defence Acquisition Procedure (DAP-2020). Additionally, from 2018 to January 2022, of the total 191 capital acquisitions made, almost 121 were inked with Indian suppliers for procuring defence equipment for the armed forces. The Make in India movement will help enhance clarity, trust, expertise, value and consistency by opening doors to innovation, besides creating jobs and opportunities to integrate the right skills.

Various initiatives have been taken to boost defence production in-house. In a way a carrot-and-stick approach is being used by the Government of India. On the one hand, various policy and funding provisions have been made to encourage the Indian private industry, MSMEs and academic institutions through grants and allocations, while on the other hand a series of Positive Indigenisation Lists (a euphemism for Negative Import Lists) have been promulgated for the three Services. A gist of the policy and funding initiatives are as listed in the succeeding paragraphs.

Policy Initiatives

Defence Production and Export Promotion Policy (DPEPP)
The policy aims to provide incentives to promote indigenous production, including tax incentives and subsidies, and promote collaboration between Indian and foreign companies. The DPEPP plans to achieve the target of defence manufacturing of Rs 1.75 lakh crore by 2025. Under DPEPP, the government has identified four strategic areas of focus, including aerospace and defence components, defence manufacturing, defence R&D and defence exports.

Liberalisation of Foreign Direct Investment (FDI)
To encourage international defence companies to collaborate with Indian companies, the Indian government has liberalised its FDI policy and is encouraging FDI in the sector, with 100 per cent FDI permitted under the automatic route in the defence manufacturing sector.[1] The easing of FDI norms has not only provided a significant boost to the sector's growth but also aims to help in the transfer of technology and knowledge.

Reforms in Offset Policy[2]
The offset policy has been reformed to encourage foreign companies to invest in defence industries and promote transfer of technology. The policy mandates that foreign companies that win defence contracts in India should invest a minimum of 30 per cent of the contract value in India's defence sector. The reforms in the Offset policy are expected to provide a significant impetus to the country's indigenisation efforts.

Positive Indigenisation Lists[3]
The Indian government has formulated four Positive Indigenisation Lists (PILs) to promote indigenisation in the defence sector. These lists consist of 101 items that the Indian armed forces require for their operational preparedness, which the domestic industry can manufacture. The first PIL was released in August 2020 and the fifth in October 2023. These lists provide a significant opportunity for the Indian industry to participate in production of defence equipment and contribute to the country's indigenisation efforts.

Collaboration with Higher Education Institutes
On the academic collaboration side, the Defence Research and Development Organisation (DRDO) has established 15 DRDO Industry Academia

Centres of Excellence (DIA-CoEs) in Indian universities and academic institutes of repute, with the objective of creating a world-class research centre developing cutting-edge technologies. These centres are established to harness and synergise the combined strength of the academia, student community, research fellows, niche technology industries and DRDO scientists to provide impetus to research and innovations.[4] However, the industry needs to collaborate more with these institutions to leverage their expertise and resources to develop new technologies.

Defence Industrial Corridors[5]
These corridors have been identified in the country to promote indigenous production in the defence sector. The corridors are located in Tamil Nadu, Uttar Pradesh, Maharashtra, Gujarat, Karnataka and Andhra Pradesh. They aim to create a conducive environment for investment, development of infrastructure and promotion of innovation and entrepreneurship in defence manufacturing.

Funding Initiatives

Technology Development Fund (TDF)[6]
The TDF aims to provide financial assistance to Indian companies to develop and manufacture critical defence equipment and systems. This programme of the Ministry of Defence (MoD) is being executed by the DRDO and will meet the Tri-Services and Defence Production requirements. The fund aims to promote collaboration between Indian and foreign companies and create a robust defence manufacturing ecosystem in the country. As per the latest updates, 163 technologies are being indigenised (Under R&D) and funding of around Rs 249 crores have been sanctioned with 5,167 companies on board.[7]

Defence Innovation Fund (DIF) and Innovations for Defence Excellence (iDEX) Scheme[8]
The iDEX initiative is coordinated by the Department of Defence Production (DDP) in the Ministry of Defence. The DIF and iDEX aim to engage industries, start-ups, innovators, institutes and academia involved in research, by creating an ecosystem to enable technology development and foster innovation. The selected start-ups and innovators will be provided grants/funding (up to Rs 10 crores in co-financing mode) and incubation facilities. They will also get access of the defence testing facilities to carry out

R&D and create prototypes in response to specific challenges or requirements raised by the three Services and Defence PSUs with the assurance of an order and Minimum Order Quantities (MOQ). The iDEX initiative aims to help create functional prototypes of products/technologies relevant for national security (prototyping) to spur fast-moving innovation in the India defence sector. It will also help new tech products/technologies find a market and early customer or user in the Indian Defence Establishment. iDEX-DIO signed its 300th contract for defence innovation on 1 December 2023[9] and more such challenges under the enhanced Aditi Initiative have recently been addressed.

Budget for Industry-led R&D

In addition to the existing provisions of DPP/DAP 20 under the Make II route, to encourage industry-led research and development, in the 2023–24 Budget, 25 per cent of the R&D budget has been allocated for the industry by the government. The move is expected to encourage the domestic industry, including MSMEs, to invest in R&D and develop new technologies and products. The initiative will also provide the industry with the necessary financial support to undertake high-risk, high-reward R&D projects.

Exports

The Indian defence industry also needs to focus on enhancing its export capabilities. The Raksha Mantri, Rajnath Singh, during the Commanders Conference held at Bhopal on 1 April 2023 announced that the exports of arms and defence technologies was creating new records and had reached Rs 15,920 crores in 2022–23, this was its maximum earnings till date, and a tenfold increase since 2016–17.[10] Despite these encouraging figures, currently, India is not a significant exporter of defence equipment, and efforts need to be made to develop indigenous technologies that can be exported to other countries.

What are we Indigenising?

As we establish the iDEX/TDF route and vet the appetite of the indigenous industry to get involved with defence production and defence R&D, let us examine what we are indigenising in the first place. A look at the list of items that have been taken up in the iDEX/TDAC route shows that we are largely producing or developing components, equipment and software. While these equipment and software will enhance the network of surveillance

or kinetic capabilities of the armed forces, their employment in standalone mode will not provide the optimum leverage. Innovation eventually needs to be integrated into larger systems. The focus has to shift from innovation and prototyping of equipment and software to systems level innovation of which these equipment will be key elements.

Need for System-Integration Approach

Contemporary defence surveillance, tracking and kinetic and non-kinetic engagement systems are cutting-edge technology at the component and equipment level. But more importantly, these systems need to be capable of integration, both backward and forward and seamlessly networked to provide synergised outputs.

Let us take the example of a quadcopter developed through the iDEX/TDF route. The drone could be used for forward observation of an area providing local extended range surveillance from a ship or a shore-based observation post. The drone would be integrated with its individual control and reporting terminal. The same geographical area could be under surveillance by a HAPS, MR aircraft, HALE or MALE with a different payload. Each system would naturally be developed to operate at its own RF link frequencies and talk back to its independent control and reporting terminal. The value of two or more of these surveillance capabilities can be optimised only when an integrated picture, using the inputs of all the available Unmanned Aerial Vehicles (UAV) is integrated with the ships AIO system. The AIO system can then carry out track designation, track identification, threat tracking and threat engagement, if required.

Once an equipment is successfully developed through iDEX and provided to an operational unit, the unit will integrate it into its SOPs and the unit will demand a level of integration with the AIO using interfaces and common symbology. We can of course then start working on interface protocols or Black Boxes to achieve the essential integration. However, each Black Box has the attendant logistics, training and maintenance load attached not to mention the real estate load in a space deficient environment like a ship or a submarine. In the absence of a plan for a focused development of technology, innovation may lead to redundancies and a re-working of systems at a later stage.

System-Integration Approach

Under this approach, all core weapons systems components should be designed and developed in coordination from the start, meeting common

standards, Interface Control Documents (ICDs) and should be compatible for integration. As a discipline, systems engineering is concerned with the whole system, rather than any single sub-system or technology. The idea is that an integrated system is a whole greater than the sums of its parts and that the entire weapons systems, and their components had to be designed or at least conceived together concurrently so that all the sub-parts could be integrated successfully.

In its broadest sense, systems integration can be defined as the capabilities which enable firms, government agencies, regulators, and a range of other actors to define and combine all the necessary inputs for a system and agree on a path of future systems development. In the narrower sense of firm capability, systems integration is concerned with the way the firms and other agents bring together high technology components, sub-systems, software, skills, knowledge, engineers, managers and technicians to produce a product.[11] In short, systems engineering-integration is an attempt to provide a systematic, multi-disciplinary approach to systems development, which is concurrent not sequential. In retrospect, the approach looks obvious and logical. Similar techniques are now widely used in the automobile and electronics industries and terms such as concurrent engineering are commonplace.

Organic System Integration

There is another form of system integration that is equally if not more essential to make a system developed through the iDEX/TDF route fully exploitable and successful in the field. For want of a better term, we could call it 'Organic System Integration'. Let us take the Quadcopter development as an example once more. The Quadcopter once successfully developed would be supplied as per the MOQ to the field units for operational exploitation. The unit would like to integrate the equipment into its operating procedure and aim to use it as a force multiplier. For this to happen there are a few prerequisites.

First, the field unit must have a full set of documents; operating instructions, first level defect identification and rectification documentation and spare part lists, at the least. The documentation should be of a standard format, which makes it predictable in content and level of detail. The components of the equipment should be fully catalogued. Each component should have a Part Number that is ideally supported by at least one vendor for assurance of availability. Naturally, the unit would only have first line or OBS and maintenance spares and the Base Depot would hold second

line spares and should be able to order and replenish the spares through a network of reliable vendors/reliable logistics supply chain. The personnel operating the equipment must be trained in the operating norms of the Quadcopter and familiar with the operating envelope of the equipment and its limitations. For this the manufacturer of the Quadcopter should be equipped to supply training simulators and emulators to the forward units and the training schools.

One could argue that the Quadcopter is a basic equipment and could be used in the Use and Throw model. But remember we are using the Quadcopter only as an example. The availability of good documentation for operations, defect rectification and maintenance, a steady supply of spares and good training will make any equipment a viable choice for the unit. It is futile to make an excellent product without these prerequisites because the operating unit is not interested in the achievement of development. It is interested in the operational availability and the leverage it gives to the unit. This is a fact that cannot be ignored.

The experience of the Indian Navy is a case in point. The Navy has been actively involved in the equipment and component level indigenisation for many decades. However, some good operationally valuable indigenised equipment was not successful because of lack of good quality documentation, comprehensive spares management and sustained spare replacement. Without effective organic integration, future orders for industry may be at risk and damage the industries' economies of scale. The 'Atmanirbharta Abhiyan' should not falter for this reason after such a comprehensive push in the last decade.

Parameters to Measure Successful Development

The growth of the defence industry of a country takes considerable time and focus because it is an R&D dependent and capital-intensive industry that requires consistent government support. Most of the Western world's defence industry is reaping the benefits of the investments, focus and whole-of-country synergy during the World Wars and the Cold War in the last century. India did not face such an existential threat during the past to create these synergies. The current initiatives of the Government of India to provide incentives and funding to encourage defence R&D, manufacturing and production are most timely. However, we must remember that these are only the first steps where the private industry and the academic institutions are being encouraged and handheld to produce equipment and components

to meet the requirements of the Armed Forces of the country. To make this a long-term, self-sustaining and profitable industry, the following conditions need to be met:

(a) The equipment manufactured by the Indian OEM must meet the expectations of the services and more importantly be operationally beneficial. The only substantive proof of the equipment being successful is the service placing repeat orders for the equipment.
(b) The equipment must be upgraded and remain contemporary with the passage of time. This specially applies to complex and expensive systems. While the AMCs may be looked after by other vendors, the OEM must maintain the in-house expertise to upgrade systems.
(c) The equipment or system developed by an Indian OEM should be exportable. Relying only on the relatively low numbers of complex equipment required by the domestic market may not be able to sustain the profitability of the business venture.

A global scan would show that most countries or their defence conglomerates are facilitating the development of defence equipment along defined use cases with standard ICD protocols through promulgation of standards and equipment Programmes. For instance, EADS, in 2007, promulgated standards for Structural Design Aspects and Criteria for Military UAV for all developers to follow.[12] Similarly, the US DARPA has in 2014 promulgated the concept of System of System (SoS) Integration, Technology and Experimentation (SoSITE) programme.[13] SoSITE seeks to develop and deliver systems architecture for rapid integration of various technologies as they are developed without the need for significant re-engineering of existing systems.

We have a long way to go before we reach the level of promulgation of common standards and SoSITE level of integration. But since we have decided as a country that we will go 'atmanirbhar', we need to leapfrog technologies and processes. Gradual evolution will waste precious time in reinventing the wheel.

It may take some time for us to achieve the conditions listed above. But as we have started to walk down this road of atmanirbharta we must look ahead and ensure the we are providing the stepping stones for this to happen. Focusing only on the first step in this long journey where iDEX challenges are raised and met and innovation is displayed through creation of successful prototypes would be short-sighted.

Some Recommendations

There is no denying the positive impact of all the policies and incentives to encourage indigenous defence equipment R&D, innovation and manufacturing in the last few years. However, we are some distance from the desired end of systems creation and export. To take the initial steps in this direction we need to add a few steps to the existing DAP, TDF and iDEX approvals process. The additional steps could be applied to the larger equipment and software initially and then be taken up for components subsequently. This will lay the foundation for the system integration approach and ensure that the equipment or systems are organically integrated with the user organisation.

The introduction of the Systems Integration Approach and Organic Integration Approach will need to be made during the development stage itself. While a start-up or innovator may find adopting the Systems Engineering approach difficult or even intimidating initially, DDP/MoD could identify System Engineering agencies that could coordinate and take on this task with the MSME or start-up. This will ensure that prototyping is not affected by these additional tasks. The proposed augmentations that could be considered by the DDP/MoD are as follows:

(a) Gradually promulgate common structural and design standards for equipment by type. For instance, for UAVs, UUVs, SAMs, ASMs, Cruise missiles, etc.
(b) Progressively promulgate broad ICD standards for each type of equipment interface. For instance, power supplies, data collection, storage, transfer from one equipment to another.
(c) Progressively promulgate data formats that could be used for the storage, downloading to the necessary network and analysis of all type of data that is gathered.
(d) Seek a System Architecture and broad concept of operations of each equipment being developed (from the Service Headquarters) to ensure that newer systems can be integrated in the future.
(e) Promulgate documentation standards which are uniform and consistent with Service operations and training requirements.
(f) Seek a Life Cycle Plan from the OEM, which should include a Life Cycle Maintenance and Upgradation plan.
(g) Seek a Supply Chain Management Plan from the OEM including complete inventory of spares and proposed suppliers.

(h) Seek a list of Training Aids from the OEM, which can include field and classroom training aids.
(i) Involve the Indian Chapter of International Council of System Engineering (INCOSE) in the formulation and promulgation of these standards and documents.

Way Ahead

The 'Atmanirbhar Bharat' initiative in defence is catalysing MSMEs, start-ups, and innovators by simplifying procedures, increasing R&D funding, and supporting prototype development. Presently these initiatives focus on equipment and component development. Future surveillance and combat military systems are complex multi-equipment integrated systems. Although our industry is not equipped for complex systems development at present, we must lay the groundwork for this transition. This can be achieved by adopting a Systems Engineering approach, promulgating equipment structural and design standards, ICDs and envisaging the larger system for the future. Similarly, to ensure that TDF/iDEX equipment is successful in the field on induction, they need to be organically integrated with the training, maintenance and logistics supply chain of the three services. Streamlining TDF/iDEX procedures can facilitate these changes effectively.

Notes

1. 'Defence Manufacturing Industry in India: Recent Development/Investments', India Brand Equity Foundation (IBEF), available at https://www.ibef.org/industry/defence-manufacturing, accessed on 10 April 2024.
2. 'Offset Policy', Department of Defence Production, Ministry of Defence, Government of India, 2021, available at https://ddpdop.gov.in/offset-policy, accessed on 11 April 2024.
3. '5th Positive Indigenisation List', Department of Military Affairs, Ministry of Defence, Government of India, available at https://mod.gov.in/sites/default/files/5th-PIL_comp.pdf
4. N. Ranjana, 'Catalysing Defence R&D In Industry & Academia – DRDO Releases 75 Technology Priority Areas For Defence R&D', *Indian Aerospace & Defence Bulletin*, 30 July 2023, available at https://www.iadb.in/2023/07/30/catalysing-defence-rd-in-industry-academia-drdo-releases-75-technology-priority-areas-for-defence-rd/, accessed on 11 April 2024.
5. 'India to Set up Defence Manufacturing Clusters in 7 States', *The Economic Times*, 30 March 2022, available at https://economictimes.indiatimes.com/news/economy/policy/india-to-set-up-defence-manufacturing-clusters-in-7-states.

6. 'Technology Development Fund, DRDO', Defence Research and Development Organisation (DRDO), available at https://tdf.drdo.gov.in/, accessed on 14 April 2024.
7. Ibid.
8. 'iDEX – Operationalization Plan for Defence Innovation Organization (DIO) & Defence Innovation Fund (DIF)', iDEX, available at https://idex.gov.in/sites/default/files/2020-10/iDEX-compendium.pdf.
9. 'Aatmanirbhar Bharat: iDEX-DIO Signs 300th Contract for Defence Innovation in the Niche Field of Design and Development of Advanced Gallium Nitride Semiconductors', Press Information Bureau, Ministry of Defence, Government of India, available at https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1981593.
10. 'Yearender 2022: How Has Atmanirbhar Bharat Changed India's Defence Industry?', *Firstpost*, 28 December 2022.
11. Michael Hobday, Andrew Davies and Andrea Prencipe, 'Systems Integration: A Core Capability of the Modern Corporation', *Industrial and Corporate Change*, Vol. 4, No. 6, 2005, p. 1110, available at https://academic.oup.com/icc/article-abstract/14/6/1109/693422?redirectedFrom=fulltext.
12. EADS UAV standards.pdf, accessed on 10 April 2024.
13. Rajesh Uppal, 'DARPA's System of Systems technology for gaining Air Superiority in A2/AD Environment', International Defense, Security & Technology (IDST), 16 August 2017, available at https://idstch.com/military/air/darpas-system-systems-technology-gaining-air-superiority-a2ad-environment, accessed on 12 April 2024.