Role of contemporary technologies in strategic programs

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Foreword

Dr. Niranjan Hiranandani

President, Assocham

Application of Technology in Indian Defence Sector

In this time and age, technology has changed the ways of age-old warfare adding new dimensions of space and cyber technology. In this new space artificial intelligence, remote sensors, scientifically advanced research, and additive manufacturing have replaced traditional methods.

The forthcoming 11th DEF Expo India 2020 will not only provide a platform to collaborate with the global giants in the futuristic technology but also strengthen the' Make in India' initiatives in the defence sector. Inviting Indian private manufacturers to join forces with their foreign counterparts to facilitate the production of defence technology to get the edge and enabling technology transfer would provide dynamic changes in the new defence scenario.

Artificial Intelligence would play God in all the future warfare. Countries like the US, China and Russia have taken giant strides in AI technology in civilian and defence sectors. AI may have larger implications in mitigating the power equations in the modern world and India would be hard-pressed to catch-up.

What India needs to put forth to achieve that is to make significant changes in the arms export policy under the Foreign Trade Policy (FTP) as well as pushing for arms export policies under UN conventions. Welcome India's private sector in defence production and incentives exports. Enabling technology transfer from various research agencies to the manufacturers, increasing the foreign investments in the sector may transform the defence industry landscape in India.

ASSOCHAM delegation under my leadership highlighted the concerns of Indian Industry towards integrating modern technology to the gamut of expertise of Indian Manufacturers to aid the Defence Forces of India in recent meeting with the Honourable Defence Minister Shri Rajnath Singh. We are hoping to receive a positive step from the Government of India in this regard at the DEF Expo 2020.

I would like to congratulate the ASSOCHAM -EY team for jointly preparing the detailed report.

I convey my best wishes for the success of the ASSOCHAM International Conference on Aerospace & Defence during 'DEFEXPO INDIA 2020'.

Foreword

Mr. Deepak Sood
Secretary General, Assocham

It gives us immense pleasure to announce the ASSOCHAM Defence Conference coinciding with the DEFEXPO 2020 at Lucknow, Uttar Pradesh on 05 February, 2020.

ASSOCHAM is working closely with the Ministry of Defence, Government of India for further simplifications of the Defence Procurement Procedure. While the Government intends to make India a manufacturing hub for the Defence Industry, ASSOCHAM welcomes the move and has started facilitating the potential exporters to international markets.

Contemporary technologies promise the intensification of modern day war. This is because of the technology driver which is the human relationship with machines. As humans become increasingly absorbed in machines and vice versa, they begin a man machine symbiosis making machines more and more intelligent each day. AI/AR/VR now act as a collaborator for humans. The extensive programming to create algorithms for these systems is done by several programmers working on the same code with little or no knowledge about the programme in entirety. For this, an impetus is being given to writing codes/programmes to facilitate communication directly with the code's user and provide easy interaction between humans and non-human entities.

The ASSOCHAM Conference will be covering the theme of 'Application of Contemporary Technologies inStrategic Programs' along with the Technical Sessions on 'Industrial Revolution 4.0 - Strategic Importance of Contemporary Technologies' and 'Strategic Programs in Defence and how will it shape the Manufacturing Ecosystem'.

I would like to thank the Ministry of Defence, for guiding and supporting ASSOCHAM in successfully organizing the Defence Conference at DEFEXPO 2020.

I also thank EY, our knowledge partner, for contributing towards the Background Paper for the Conference.

Foreword

Col K V Kuber
Director, Aerospace and Defence, EY

Technological advancement is the amongst the defining characteristics of a mature industry in strategic sectors. Defence sector is among sectors which are highly impacted with changes in technology. . Electronic warfare, for example, is as applicable to an airborne platform as it is to a maritime asset or to an armored fighting vehicle or to a standalone land-based electronic platform. The technology remains the same while applications are tweaked to suite implementations.

Modern warfare is defined by a plethora of weapon systems working together, from contemporary to conventional, in a battlefield. The contours of the battlefield may often change with little reaction time. Commanders at all levels may be faced with one major concern, i.e., information overload.

Handling of big data, processing of data into information and squeezing intelligence from information would be the key to decision making. Timely decision making is a key battle winning factor. All this can happen only when contemporary technologies are effectively integrated into platforms and systems.

With India embarking on the journey to develop and enhance key strategic programs such as submarines, aircrafts, tanks, helicopters as well as academia investing in contemporary technologies, it is time for a holistic approach to integrate the two sides. What we do today will reflect in what we expect from the battlefield of tomorrow. For example, a night vision device that is integrated with AI could effectively predict and in time, detect and accurately identify a target for an effective engagement. Thus, allowing the solider in the battle field to execute the decision with little strain on the human eye. This is true for every system and every platform.

With a focus on strategic independence, the impetus lies on strengthening indigenous capabilities in defence manufacturing and this would not be possible without the rapid integration of contemporary technologies.

Contents

Market dynamics

Artificial Intelligence (AI) is becoming a critical part of modern warfare. Compared to conventional military systems, those equipped with AI are capable of handling larger volumes of data more efficiently. Additionally, AI improves self-control, self-regulation, and self-actuation of combat systems due to the inherent computing and decision-making capabilities.

Over the past few years, the defence forces have deployed learning action frameworks which use machine learning algorithms and AI to imitate the human faculties of learning, memory and judgment. Common technologies in the big data ecosystem such as Apache Hadoop, Apache Hive / Apache Pig, Apache Sqoop, Inmemory Databases, NoSQL Databases and MPP Platforms are used by defence forces globally and technology companies have developed systems to display the common operational picture for the defence forces.

Machine learning, which is one of the most new and popular technologies in defence, is used by many countries such as the US, China and Russia to respond to unknown threats in order to reduce the burden on war fighters. However, an artificial intelligence system needs to be in a dynamic closed loop with the feedback system to respond intelligently in case an uncertain threat is found.

The artificial intelligence in military market was valued at US$5.54 billion in 2016 and is projected to reach US$18.82 billion by 2025, at a CAGR of 14.75% during the forecast period.[1]

AI is deployed in almost every military application and increased research and development funding from military research agencies to develop new and advanced applications of artificial intelligence is projected to drive the increased adoption of AI-driven systems in the military sector.[2]
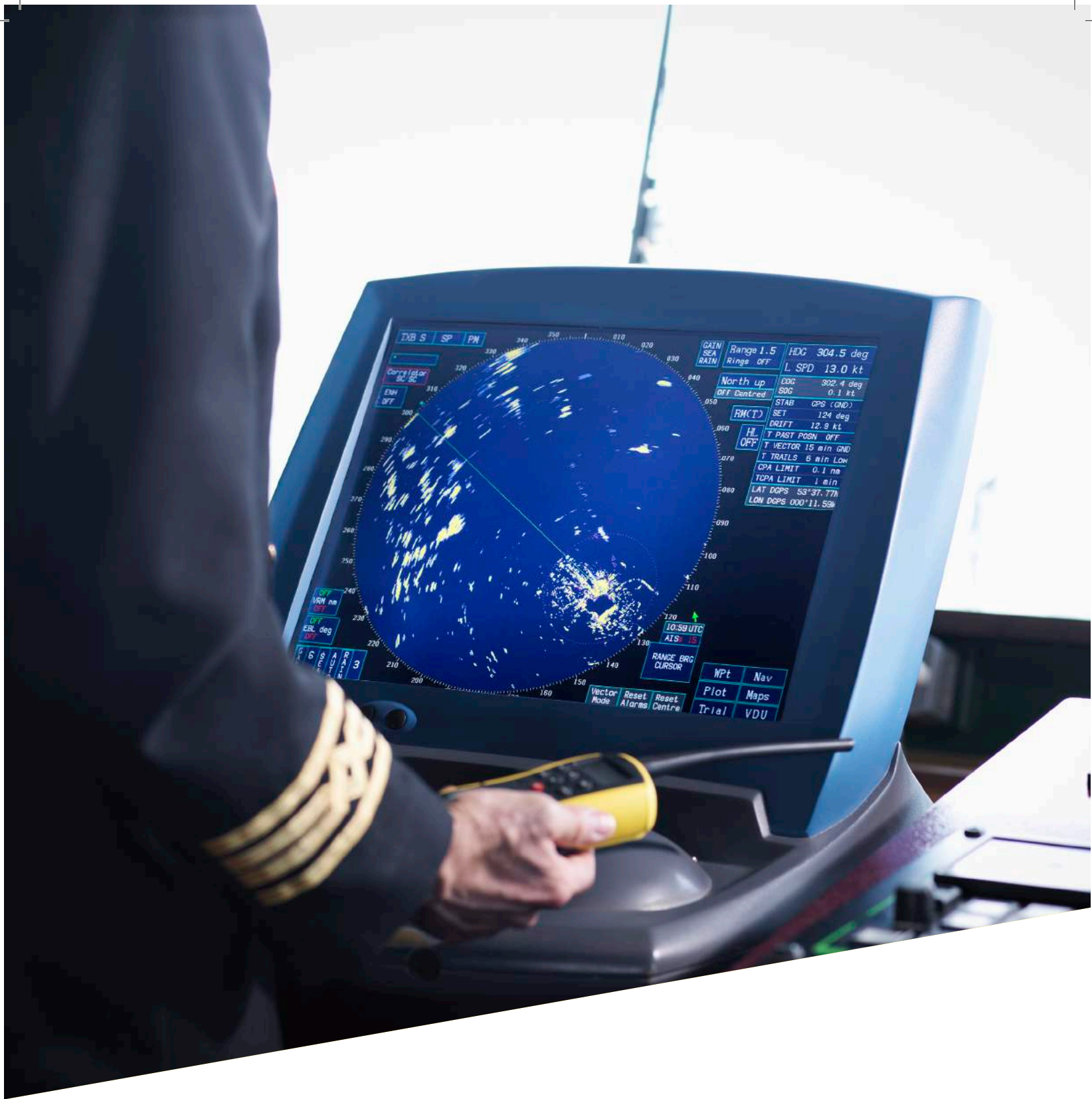
Efforts for AI adoption in India

‣ **Multi-stakeholder task force:** To study the whole gamut of issues surrounding the strategic implications of AI in the perspective of national security, in a global context, a multi-stakeholder task force represented by members from the government, services, academia, industry professionals and start-ups was constituted in February 2018.[2]

‣ **Established a High-Level Defence AI Council (DAIC)[3]:** DAIC was constituted to provide necessary guidance to enable and effect development or tailoring of operating framework, policy level changes and structural support. The DAIC has been entrusted with the responsibility of ensuring AI adoption as a part of defence strategy and provide strategic direction towards AI-driven transformation in defence.

‣ **AI training of defence personnel:** In order to develop a critical mass of data analysts, data scientists and AI specialists, MoD organizations, including services, will be encouraged to introduce appropriately designed training modules in their in-service trainings.[4]

‣ **Funding:** Each service headquarters (SHQs) has been directed to earmark INR100 crores for AI specific application development in each year for next five years from their annual budgetary allocations.[4]

‣ **Budget:** A budgetary allocation of INR100 Crores made by MoD each year for the next five years to the Defence AI project Agency (DAIPA) for the implementation of recommendations given by the AI Task Force including taking up AI projects, setting up AI-related infrastructure, clearing and preparing AI-related data, capacity building, etc. in MoD organizations.[4]

1   https://www.marketsandmarkets.com/Market-Reports/artificial-intelligence-military-market-41793495.html?gclid=EAIaIQobChMI1_GA5OHJ5gIVIzMrCh10zANiEAAYASAAEgLYOPD_BwE

2   https://blog.marketresearch.com/8-key-military-applications-for-artificial-intelligence-in-2018

3   https://ddpmod.gov.in/sites/default/files/AI.pdf

Tactical application of contemporary technologies

1. Warfighting platforms

Defence forces in countries across the globe are embedding AI into weapons and other systems used on land, naval, airborne and space platforms.

Using AI in systems based on these platforms has enabled the development of efficient warfare systems, which are less reliant on human input. It has also led to increased synergy and enhanced performance of warfare systems while requiring less maintenance. AI is also expected to empower autonomous and high-speed weapons to carry out collaborative attacks.

2. Cybersecurity

Military systems are often vulnerable to cyberattacks, which can lead to the loss of classified military information and damage to military systems. However, systems equipped with AI can autonomously protect networks, computers, programs and data from any kind of unauthorized access.

In addition, AI-enabled web security systems can record the pattern of cyber-attacks and develop counter-attack tools to tackle them.

3. Logistics and transportation

AI is expected to play a crucial role in military logistics and transport. The effective transportation of goods, ammunition, armaments and troops is an essential component of successful military operations.

Integrating AI with military transportation can lower transportation costs and reduce human operational efforts. It also enables military fleets to easily detect anomalies and quickly predict component failures. Recently, the US Army

collaborated with IBM to use its Watson artificial intelligence platform to help pre-identify maintenance problems in Stryker combat vehicles.

4. Target Recognition

AI techniques are being developed to enhance the accuracy of target recognition in complex combat environments. These techniques allow defence forces to gain an in-depth understanding of potential operation areas by analyzing reports, documents, news feeds, and other forms of unstructured information. Additionally, AI in target recognition systems improves the ability of these systems to identify the position of their targets.

Capabilities of AI-enabled target recognition systems include probability-based forecasts of enemy behavior, aggregation of weather and environmental conditions, anticipation and flagging of potential supply line bottlenecks or vulnerabilities, assessments of mission approaches and suggested mitigation strategies. Machine learning is also used to learn, track, and discover targets from the data obtained.

For example, DARPA's Target Recognition and Adaption in Contested Environments (TRACE) program uses machine learning techniques to automatically locate and identify targets with the help of Synthetic-Aperture Radar (SAR) images.

5. Battlefield healthcare

In war zones, AI can be integrated with Robotic Surgical Systems (RSS) and Robotic Ground Platforms (RGPs) to provide remote surgical support and evacuation activities. The US in particular is involved in the development of RSS, RGPs and various other systems for battlefield healthcare. Under difficult conditions, systems equipped with AI can mine soldiers' medical records and assist in complex diagnosis.

For instance, IBM's Watson research team partnered with the US Veterans Administration to develop a clinical reasoning prototype known as the Electronic Medical Record Analyzer (EMRA). This preliminary technology is designed to use machine learning techniques to process patients' electronic medical records and automatically identify and rank their most critical health problems.

6. Combat simulation and training

Simulation and training is a multidisciplinary field that pairs system engineering, software engineering and computer science to construct computerized models that help acquaint soldiers with the various combat systems deployed during military operations. The US is investing increasingly in the simulation and training applications.

The US Navy and Army have each been conducting warfare analysis, which has led to the initiation of several sensor simulation programs. The US Navy has enlisted such companies such as Leidos, SAIC, AECOM and Orbital ATK to support their programs, while the US Army's programs are supported by firms including SAIC, CACI, Torch Technologies, and Millennium Engineering.

7. Threat monitoring and situational awareness

Threat monitoring and situational awareness rely heavily on intelligence, surveillance, and reconnaissance (ISR) operations. ISR operations are used to acquire and process information to support a range of military activities.

Unmanned systems used to carry out ISR missions can either be remotely operated or sent on a pre-defined route.

Equipping these systems with AI assists defence personnel in threat monitoring, thereby enhancing their situational awareness.

Unmanned aerial vehicles (UAVs) – also known as drones – with integrated AI can patrol border areas, identify potential threats and transmit information about these threats to response teams. Using UAVs can thus strengthen the security of military bases, as well as increase the safety and efficacy of military personnel in battle or at remote locations.
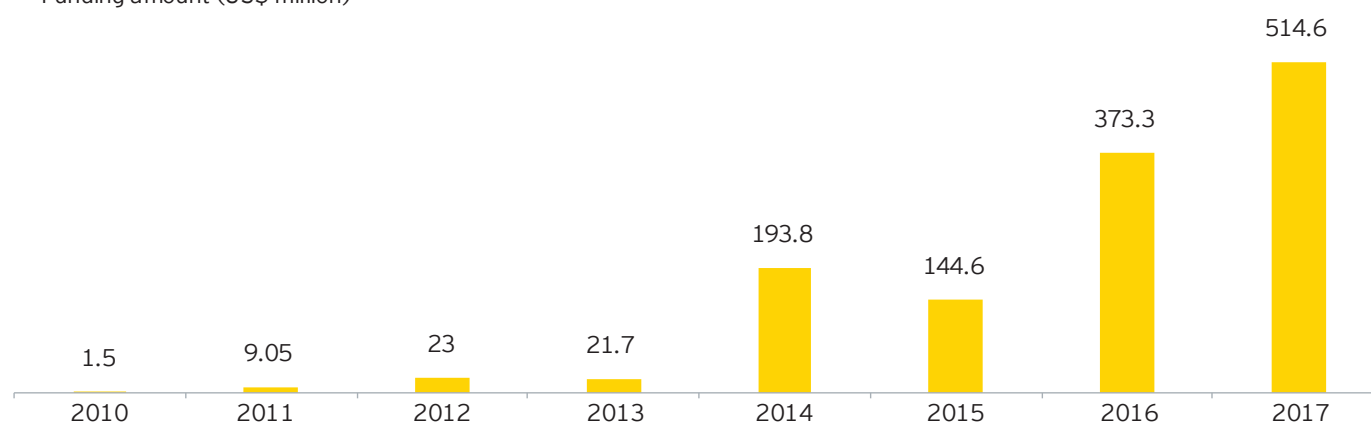
8. AI and data information processing

AI is particularly useful for quickly and efficiently processing large volumes of data in order to obtain valuable information.

AI can assist in culling and aggregating information from different datasets, as well as to acquire and sum supersets of information from various sources. This advanced analysis enables military personnel to recognize patterns and derive correlations.

Analyzing the global investment trend in AI companies, Chinese investments in US companies involved in AI or related fields have increased drastically from US$1.5 million in 2010 to US$514.6 million in 2017. It raises a concern of national security in terms of data protections and cybersecurity. The following table shows to global proliferation of Chinese investments in US AI companies[4]:

Figure 1. Chinese inventment in US AI companies, 2010-2017

■ Funding amount (US$ million)

2010	2011	2012	2013	2014	2015	2016	2017
1.5	9.05	23	21.7	193.8	144.6	373.3	514.6

4   https://fas.org/sgp/crs/natsec/R45178.pdf

Role of AI/AR/VR in future wars

Along with classic threats such as hacking and spoofing, an entirely new set of technology, like AI/AR/VR, is going to play a transformative role future war. This include autonomous weapons such as UAVs, missiles, etc. If fully autonomous weapons have not been developed yet, semi-autonomous weapons and robotic systems employing AI have been developed or are under improvement across the globe. Hence, it will not be false to say that self- directed and independent weapons are not just the technologies of the future, they are already here. The Long Range Anti-Ship Missile (LRASM) developed by Lockheed Martin for the US Airforce and Navy is believed to have semiautonomous capabilities that use AI technology to counter electronic defences and reach designated targets without the use of standard navigation aids. Lockheed Martin has reported in the past that a LRASM test demonstrated the ability to load mission data before flying a pre-planned flight profile to a pre-determined endpoint. However, for now, AI capabilities for "intelligent" cruise missiles appear to be restricted to evading electronic countermeasures and other threats, navigating independent of the Global Positioning System and bypassing enemy ships not on target lists.[5] The US anti-submarine vessel Sea Hunter requires no crew. It navigates using a specially designed AI, which gets its data from sensors, radars and cameras installed on the vessel.[6] Israel uses the HAROP which is a standoff loitering attack weapon system designed to locate and precisely attack targets.[7]

Armed forces have a vast fleet of diverse vehicles and equipment. AR and VR will enhance the future soldiers' capability to operate a wide range of vehicles and equipment with less training. They have a very important place in the future with reference to training and simulation. VR introduces another dimension other than what is provided by current weapon training simulation system (WTSS). These technologies allow the simulation of a multitude of diverse spaces.

The competition in the field is likely to shape future wars. Different countries essentially have similar opinions about these technologies. China has referred to AI as a strategic technology in its national strategy paper 2017. The French Defence Strategy Document says AI is a must have for superiority in the battlefield. The US believes it must be a pioneer when it comes to AI to maintain its dominance in the sector. It presented this in a report in 2017 and Pentagon formulated a strategy called "Third Offset" regarding the same. This strategy emphasizes on a leading position in AI along the same lines of nuclear weapons and long-range precision engagement technologies. To win future wars, winning in contemporary technologies today is essential.[8]

5   https://defensesystems.com/articles/2017/02/09/chinait.aspx

6   https://www.marketwatch.com/story/drone-warship-sea-hunter-of-the-us-navy-is-powered-by-artificial-intelligence-2019-07-03

7   https://www.iai.co.il/p/harop

8   https://www.behorizon.org/how-will-artificial-intelligence-change-the-character-of-war/

Growing adoption of contemporary technologies

The manufacturing sector is undergoing a seismic shift in its composition. This disruption within the sector is driven by the emergence of certain advanced/contemporary technologies. These technologies have led to a cross-sector transformation or revolution in the manufacturing process and ultimately the aggregate supply chain. The manufacturing process transformation is intended to congregate digital and physical capabilities to ultimately yield better and more efficient processes and a higher degree of integration and interlinking within the supply chain (between suppliers, manufacturers, customers). The aerospace and defence sector(s) are no stranger to embracing new technologies and in some respects, has been a pioneer in this regard. These contemporary technologies are not only causing change within the manufacturing process, however, they are allowing for the creation of smarter products and opening new market opportunities for manufacturers within the sector. Data capture through sensors and advanced analytic techniques is a great example in this regard; a system such as an engine and airframe health monitoring system has allowed for operators (such as airlines) to conduct planned maintenance activities (hence allowing for higher operational efficiency), it has also expanded the reach of OEMs in terms of service offerings to target the MRO business through a higher technology product offering.

Some of the key contemporary technologies that are redefining defence manufacturing and ultimately global value chains are the following[9]:

▸ **3D printing/additive manufacturing:** OEMs and suppliers can utilize 3D printing technology to customize products to customer specifications. More importantly, these 3D printers can manufacture parts from different materials including titanium, tungsten, and composite materials. This technology allows for a higher degree of accuracy combined with higher reliability (from a quality standpoint); however, more importantly it reduces the OEMs dependence on suppliers through a reduction in supplier volume pool. With the OEM having an ability to do a wider variety of tasks, one could argue that this allows the OEM to pursue a degree of backward integration in the supply chain.

▸ **Artificial Intelligence:** From an OEM's standpoint, insights gained from machine learning enable more capable products. As OEM's expand their usage of artificial intelligence and machine learning in the development of autonomous systems, there could be the emergence of platforms that are self-sufficient in the field of combat and are able to take battlefield and other operational decisions on their own. An example of this could be, UAVs, where they could possess the ability to make battlefield decisions. Suppliers on the other hand could utilize artificial intelligence and machine learning for continuous monitoring and analysis of machine health, thereby allowing suppliers to predict breakdowns and allowing better operational optimization.

▸ **Utilization of advanced materials:** The materials that are used in the manufacture of structure, engine components and the overall platform are witnessing a rapid change. Over the past two decades, manufacturers have invented new alloys and new materials in the manufacture of a wide-range of products. These new materials offer distinct advantages through offering a higher degree of structural integrity, protection, and a capability to operate in all weather conditions, while doing so at a fraction of the weight, thereby achieving certain cost savings.

▸ **Augmented reality:** Augmented reality's impact is primarily witnessed in the maintenance, repair and overhaul (MRO) business, through the provision of information to maintenance engineers about critical parts and visibility to maintenance activities that maybe happening in another part of the world.

▸ **Cloud, mobile and analytics:** Enable supplier efficiency and connect with suppliers further down the supply chain to lead to a more efficient supply chain. OEMs utilize data analytics to provide predictive maintenance, monitor performance of shop floor assets; along with subsequent optimization.

9   https://www.ey.com/en_gl/aerospace-defense/how-digital-technologies-are-transforming-aerospace-and-defense

‣ **IoT and sensors:** Enable the collection of operational data from production floor assets, which can help OEMs and suppliers predict maintenance requirements, monitor performance and create a more efficient production floor, with less down time for machines.

Some use cases of contemporary technologies

‣ **3D printing/additive manufacturing:** A major American aero-engine manufacturer is 3D-printing turbine blades for the world's largest jet engine. A single machine has the ability to simultaneously print six turbine blades directly from a computer aided-design diagram through the utilization of a 3-kilowatt electron beam. The electron beam creates the blades, which are 40 centimeters long, by welding together thin layers of the powder of a titanium aluminum alloy, one after another.

‣ **Advanced materials:** Titanium Aluminide (TiAl) is an example of an advanced material that provides a high degree of structural integrity along with being heat resistant. It weighs approximately 50% less than conventional alloys (typically nickel alloys) used in aerospace manufacturing. The material is brittle in nature and requires a very specific and cost-prohibitive molding process to shape it. However, utilizing a modified 3D printing machine with a certain procedure, allowed for the material to be utilized in the manufacture of turbine blades on certain next generation engine models. Through these new advanced materials and technologies, it is likely that the engine model is question will likely be 10% more fuel-efficient than its predecessor.[10]

‣ **Augmented Reality (AR):** An Australian aerospace company has designed a wearable-assisted system that utilizes augmented reality to connect on-the-ground technicians to liaison or interact with experts globally to solve maintenance challenges in real-time. The system is expected to reduce the overall repair time required for a grounded aircraft/platform as it does not require specialists to travel. This could prove vital within the Indian context, particularly for Indian Air Force operations that are carried out in remote parts of the country. For example, AN-32 operations in the Northeast of the country, require landings at remote airstrips that may not necessarily be equipped with the required facilities and unforeseen maintenance could be required. Using AR, maintenance specialists could assess the situation and propose a solution without having to be physically present.

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10   https://www.ge.com/reports/future-manufacturing-take-look-inside-factory-3d-printing-jet-engine-parts/

▸ **IoT and Sensors:** A US-based aircraft engine manufacturer has installed over 5,000 sensors installed on aircraft that are powered by its next generation engine models. The sensors are connected through Internet of Things (IoT) and have the capability to generate up to 10GB of data per second. This data collection allows engine manufacturers to utilize data to predict engine life, improve fuel efficiency and reduce noise and emissions. Predicting engine life could prove crucial for optimization of operations by predicting when predictive maintenance could be required and accordingly plan asset allocation/resource planning in an operational scenario. Improving fuel efficiency, along with a reduction in emissions are operational considerations that could be enabled and executed to a better degree.

Contemporary technologies will play a crucial role going forward in the defence sector. As seen from the use cases highlighted above, these technologies not only have an impact to make in manufacturing, however, from an operational standpoint; emerging technologies are likely to give an operational and tactical advantage to armed forces that utilize them. These technologies manage to optimize the entire operation (be it manufacturing or military operations) thereby allowing for a more cost-effective and efficient setup.
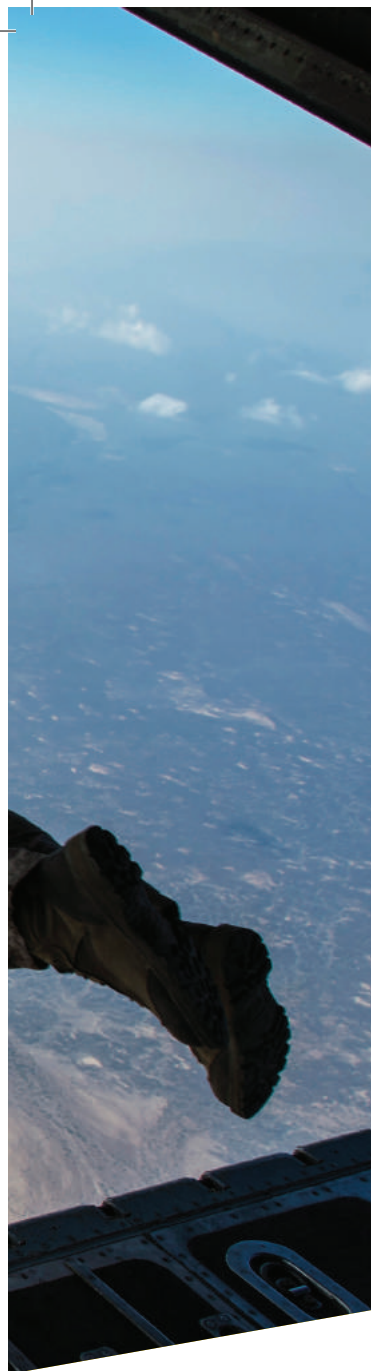
Readiness of the Indian Armed Forces

India realizes the significance of contemporary technologies such as AI/AR/VR specifically for the armed forces through use of robotics and autonomous systems. In February 2018, a multi-stakeholder task force was set up for the Strategic Implementation of AI for National Security and Defence. Based on the report submitted by it, in February 2019, the MoD established a Defence AI Council (DAIC) chaired by the Minister of Defence. The report also discussed capacity building within defence by fostering learning and creating a wealth of knowledge on contemporary research and developments in AI. Defence organizations would also need to contribute significantly in terms of research articles, data, patents, knowhow, trade secrets and licensing of these intellectual properties. To enhance their knowledge, AI training courses are to be introduced in all defence training centers and institutes and AI training of defence personnel will be provided. The report mentioned a budgetary allocation of INR100 crores shall be to the MoD each year for the next five years for implementation of recommendations given by AI Task Force including taking up AI projects, setting up AI related infrastructure, clearing and preparing AI related data, capacity building, etc.[11] DAIC is tasked to provide strategic direction towards adopting AI in defence. DAIC will to monitor the partnership between the Indian Government and industry. It will also review the recommendations related to technology acquisition. DAIC also overlooks the formation of a Defence AI Project Agency (DAIPA) as the central executive body. Recently, an announcement was made by the Defence Ministry

which said that 25 defence-specific AI products would be developed in the next five years. In the beginning of 2019, the Indian Army Chief, General Rawat also stated the importance of AI in the army and emphasized on what its late adoption would mean to the defence forces.[12]

The Centre of Artificial Intelligence and Robotics (CAIR) of the DRDO is working on the development of autonomous technology-based products with a focus on the net-centric communication system for tactic command controls. CAIR has already developed intriguing probes for surveillance and reconnaissance.

Across the world, efforts have been begun with a focus on AI. For instance, the UAE has recently inaugurated EDGE with more than 25 entities, including subsidiaries from the Emirates Defence Industries Company (EDIC), Emirates Advanced Investments Group (EAIG), Tawazun Holding and other independent organizations consolidated in it to focus on AI across all of its products. It has been reported that the company is expected to implement advanced technologies such as autonomous capabilities, cyber-physical systems, advanced propulsion systems, robotics and smart materials and the convergence of innovations from the commercial and the military industry. Innovation is the area where EDGE will attract industry experts and talent from around the globe, who will help to build platforms in some core areas like electronic warfare and intelligence, missiles and weapons and cyber defence. UAE has expressed interest in some Indian missile systems like Akash surface-to-air missile and BrahMos missile. Officials from the UAE are also interested in DRDO developed Astra 70-kilometre range air-to-air missile.[13]

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11 https://elplaw.in/wp-content/uploads/2019/02/190213-Implementation-of-Artificial-Intelligence-in-Indian-Defence-Services.pdf

12 https://www.esds.co.in/blog/how-ai-strengthens-the-indian-army/#sthash.nnhJxU6s.dpbs

13 http://www.indiandefensenews.in/2019/11/uae-based-edge-to-work-together-for.html

Another example of use of AI is by the Indian Army in Kashmir. Human life is not a matter of debate and to ensure security of all personnel, amid several incidents of casualties during counter-terror operations, the Indian Army has decided to use robots and AI to help hundreds of thousands of soldiers deployed in Kashmir. The robots can also use the stairs or passages to deliver grenades to any desired locations. In addition to this, the Indian Army wants all-weather and water-proof robots to negotiate any obstacle to deliver desired results at ease. The system should transmit visual data to an approximate distance of 150-200 meters across four walls.[14]
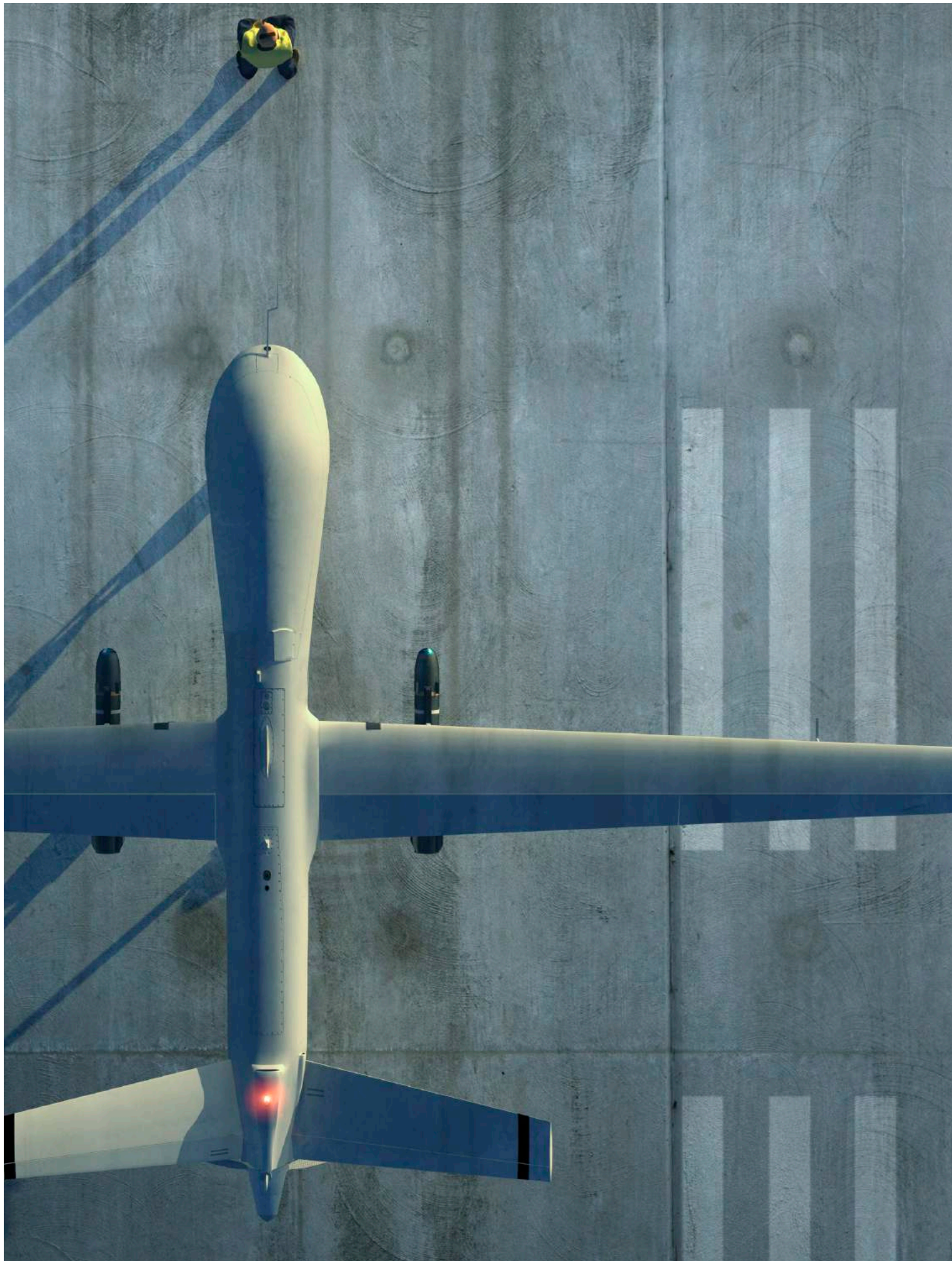
Daksha developed by DRDO is India's first anti-terror robot. It is a Remotely Operated Vehicle (ROV) is built for anti-terror activities. An electrically powered robot, it can be controlled by wireless communication over 500m line of sight or by fiber optic communication over 100m distance and can be used continuously for three hours after a single recharge. There are around 500 Daksha going to be inducted in the Indian Army. Daksha is primarily designed for the safe handling and destruction or detection of IEDs using multiple cameras, X-ray devices. It has a shotgun, which can break closed doors. The scanner installed in it can scan cars to check for explosives. The Daksha robot has been developed by R&DE – Engineers in collaboration with TATA Motors, Theta Controls, Bharat Electronics (BE) and Dynalog (I).[15]

Indian Armed Forces also face certain challenges in adopting these technologies. Firstly, policy makers need to have a clear vision of the strategic importance of AI/AR/VR and the consequent need of budgetary allocations for the same. Secondly, the lack of infrastructure poses a critical challenge. AI specifically requires robust hardware to bank data for algorithms and hence it is necessary to properly and securely house it within the sub-continent. Thirdly, the private sector plays a significant role in developing efficient AI/AR/VR capabilities in the county. Private sector needs to be tapped to bring in high skill-set, capital and innovations.

14   http://www.indiandefensenews.in/2019/11/indian-army-to-use-all-weather-robots.html

15   http://www.indiandefensenews.in/2019/11/daksha-countrys-first-anti-terror-robot.html

An overview of the Strategic Partnership Policy

The Strategic Partnership Model, first mentioned in the Dhirendra Singh Committee report in July 2015 and further detailed out in the Aatre Committee report in December 2015, was finally approved as a policy – albeit in a revised version. The intent is to develop a comprehensive industrial eco-system within the country while focusing on indigenous manufacturing.

With a vision to create capacity in the private sector on a long-term basis, over and above the capacity existing in the public sector – the policy has seen two years and two different ministers. Harmonizing the policy with initiatives such as Make in India and coupled with path breaking reforms in industrial and FDI policies, the policy is a welcome development for the benefit of the private Indian defence industry.

The concept and fundamentals were laid down by the Dhirendra Singh Committee. To quote, "There are cases however where certain platforms are of strategic importance. For these, we are recommending the 'Strategic Partnership model' for creating capacity in the private sector on a long term basis. Such a capacity will be created over and above the capacity and infrastructure that exists in Public Sector units. This is expected to spur the sectors towards a more efficient and effective mode of operation. Likewise, there are cases where quality is critical and vendor base is very narrow. For these we are recommending a model of 'development partnership". The committee further recommended few segments that could be identified for long term partnerships, including:

‣ Platforms including their major systems:

 ‣ Aircraft (fighter, transport and helicopters)

 ‣ Warships and submarines

 ‣ Armored Fighting Vehicles (AFVs)

‣ Weapons:

 ‣ Complex weapons including anti-ship, air defence, air-to-air, air-to-surface, anti-submarine and land attack

‣ Networks:

 ‣ Command, control, communication and computers, intelligence, surveillance, target acquisition and reconnaissance

‣ Materials:

 ‣ Critical materials (titanium and aluminum alloys, carbon composites, nickel / cobalt alloys, etc.)

A brief overview:

| May 2015 Dhirendra Singh Committee set up | July 2015 Report of the Dhirendra Singh committee submitted | September 2015 V.K. Aatre Committee set up | December 2015 Report of the Aatre Committee submitted | 09 May 2017 Draft policy formed | 31 May 2017 Final policy approved |

The Aatre Task Force further streamlined the segmentation under two separate groups classifying them as system of system projects and other projects respectively:

Group I segments	Group II segments
Aircraft	Metallic material and alloys
Helicopters	Non-metallic material (including composites and polymers)
Aero engines	Ammunition including smart ammunition
Submarines	
Warships	
Guns (including artillery guns)	
Armored vehicles including tanks	
A maximum of 13 Strategic Partners (SP) to be selected	
7 SPs (one for each segment)	6 SPs (two for each segment)

The Task Force recommended aircraft, helicopters, submarines and armored vehicles including tanks in Group I and ammunition including smart ammunition in Group II to be considered for selection in the initial phase.

Taking a cue from the Aatre Task Force report, a draft policy was prepared which laid down qualification criteria with the financial and technical parameters for selection. The final Strategic Partnership Policy was released on 31 May 2017.

The Strategic Partnership Policy

The seventh chapter of the DPP 2016 on Strategic Partnership Policy is divided into sections with an introduction to the model, the identified segments and the organization structure forming the first section. The second section details the selection procedure.

The policy targets to create an ecosystem including the SP itself which is expected to be the system integrator with other stakeholders including, among others, development partners, specialized vendors and suppliers – especially from the MSME sector.

The segments identified include:

‣ Fighter aircraft

‣ Helicopters

‣ Submarines

‣ Armored Fighting Vehicles (AFV) / Main Battle Tanks (MBT)

Since the manufacturing set up would require an SP to tie-up with OEMs, the policy has left it to the concerned parties to come to an arrangement amongst themselves – be it in the form of a JV, or an equity arrangement, or technology sharing or any other mutually acceptable arrangement. The only condition is on the ownership front, where the SP has to be an Indian company with maximum 49% FDI allowed. However, the calculations of foreign equity will not include investments by Foreign Institutional Investors (FII) and Foreign Portfolio Investors (FPI).

The selection process requires the applicant company to be an Indian resident and to have control over the policy decisions and appointment of directors. The Minimum Qualification Criteria (MQC) to be met include having a system of systems integration capability along with required financial parameters whose threshold limits would be specified in the EOI / RFP. Miscellaneous factors that would also be considered include no willful default to the banking system as on the date of application. The MQC also includes a segment specific criterion for each of the four segments and it would be a measure during evaluations.

Submarines	‣ Infrastructure: Availability of at least one suitable dry dock or building bay and at least two slots for water frontage ‣ Should have successfully delivered a warship / ship as a prime contractor in the last five years
Fighter aircraft / helicopters	‣ Availability of hangar and land space ‣ Experience in production of system / components ‣ Availability of machining / processing facilities for composites
AFV / MBT	‣ Availability of mobility track, test driving track ‣ Simulation and modeling capabilities ‣ Integration of complex systems ‣ Processing facilities for metals and composites

The selection process of the SP and the OEM will happen in parallel in an attempt to speed up the process.

Selection of SP	Selection of OEM
Issue of EOI to Indian companies	Issue of RFI
Responses including choice of segments and details on MQC	SQR formulation
Evaluation based on MQC	Issue of EOI to OEMs in each segment
Verification of segment specific criteria	OEMs to respond within two months
Shortlisting of companies meeting the criteria	Technical Evaluations
Issue of segment wise RFP	Shortlisting OEMs for each segment

The key driver for selection of the OEMs will include the quantum and the scope of technology transfer detailed as under:

‣ Range, depth and scope of transfer

‣ Indigenous content proposed

‣ Extent of ecosystem development proposed

‣ Measures to support SP in establishing systems for integration of platforms

‣ Future R&D planned in India

‣ Plans to train skilled manpower

The RFPs would require applicants to submit technical details of the equipment and the commercial offer (including 10 year performance-based logistics or other maintenance arrangements).

The SPs are then free to engage with the OEMs in order to submit a response where one SP can submit only one offer with one OEM (except for segments like helicopters which have diverse platforms). The technical and commercial evaluations will then be carried out and the one with the least bid price will be designated as the winner.

There are other very specific inclusions in the final policy which were not clear in earlier deliberations:

- Flexibility to applicant company to rely on group company(ies)'s experience in the identified segment. However, the group company(ies) will not be appointed as SP – only their experience will be considered for evaluation.

- MoD can consider DPSU / OFB involvement at an appropriate stage if and when required.

- Maximum 10-15% of to-be-produced-units can be manufactured in OEM's premises for training and skill development of SP's manpower.

- Contract cancellation can be done due to any one of the below mentioned reasons:

  - Material breach of contract / integrity related provision

  - If the SP or JV/SPV loses 50% of net worth from the date of application or if it is unable to pay dues / adjudged insolvent / voluntarily winds up

  - Non-compliance of any other contractually relevant issue

The role of contemporary technologies in strategic programs

As highlighted in an earlier section of this knowledge paper, contemporary/emerging technologies are already being rapidly utilized in the aerospace and defence manufacturing sector and broader manufacturing sector. These technologies have created smarter products, optimized processes, helped with cost efficiencies and boosted productivity for both manufacturers and their supply partners (across-tier levels).

Contemporary technologies have seen use cases being established across the manufacturing supply chain, from the component level, to the structural and also aftermarket services. When looking at the strategic partnership model, particularly when looking at certain criteria for participation, selection and the overall investment requirements of the Indian strategic partner, there is a scope to see how contemporary technologies could have a deciding impact on how effective the model is in enhancing the country's defence manufacturing and overall defence industrial base.

The model envisions the strategic partner to be the systems integrator, tasked with creating a domestic tiered structure supply chain consisting of development partners, specialized vendors and suppliers. A key parameter that a strategic partner should take into consideration is the use of contemporary technologies in existing supply chains within the company. For example, if a well-established manufacturer is bidding (as the Indian SP) for an SP program and there is a requirement for a certain component (that has been identified to be manufactured indigenously) as a part of a larger system/sub-system, the

SP would need to do the following: firstly, the SP would need to examine its own existing supply chain to examine the transferability of the component/system/sub-system onto the platform. Second, it would need to examine whether emerging technologies are being utilized in the existing supply chain and the viability of transferring over the use of this contemporary technology into the manufacturing process of the required component for the platform in question, i.e., does it concur with transfer of technology/OEM specified procedures. For instance, is additive manufacturing technology/3-D printing utilized in the manufacturing process and can this be process be used for production of a similar or different component for the SP platform. From the supply chain standpoint, a new supplier looking to assimilate into the SP's supply chain would need to evaluate the case for investment into emerging technologies such as additive manufacturing (should they not already possess the capability) for manufacture of the component, as this could drive cost efficiencies, higher productivity and capability; allowing them to offer a more attractive bid to the SP (which ultimately translates into the SP being able to offer a lower bid price to the customer, enabling a better chance of lowest bid (L1 bid). The knock-on effect that is created across the supply chain through utilization of emerging technologies could be significant and could open opportunities to different suppliers.

The ability to offer a higher technology product/offering is another bigger factor to examine the effect of emerging technologies on strategic programs. In an earlier section of this report, an example of an aircraft engine manufacturer that has installed over 5,000 sensors in the engine that are connected through IoT and generate about 10GB of crucial engine data per second; allowing for the engine manufacturer and operator to better predict engine life, improve fuel efficiency, etc. Incorporating technology such as this could enable a higher technology and overall better product as compared to competition. This is crucial given the Indian Armed Force's aim to modernize and focus on acquisition of state-of-the art equipment. In addition to this, by this same logic the utilization of contemporary technologies to create a higher technology product/offering could open up the export market to India as well, thereby not limiting the level of investment required from the SP to

be contingent on one buyer and reducing the monopsonic risk factor that the defence sector is usually categorized by.

The SP model aims to ensure that certain landmark defence programs which are categorized in the identified SP segments, such as the Naval Utility Helicopter program or MMRCA 2.0 (Fighter Aircraft program) create the required manufacturing ecosystem to carry out subsequent acquisitions under the Buy (Indian-IDDM), Buy (Indian), Buy and Make (Indian) and Make categories of procurement. The SP model requires long-term investments in capacity creation and capability development including infrastructure, a tiered supply chain structure, skilled human resources and investment in R&D. Taking this into consideration along with the relevance of contemporary technologies, the policy mentions that in subsequent acquisitions in the identified segments/platforms, adequate weightage may be provided to the development and acquisition of relevant technologies and execution of advanced and state of the art manufacturing processes. While this provision in the policy is one of implementation with a long-term focus, SPs looking to participate in programs of such magnitude should target making investments as early as possible. An SP and the SP's suppliers that can build expertise in the identified disciplines/segments (of the SP policy) for manufacture of platform, systems, sub-systems, while being able to utilize emerging technologies would be able to better use investments for more efficient integration into global aerospace and defence supply chains. This capability would give India the ability to become a defence manufacturing hub. Contemporary technologies are already in use throughout global defence manufacturing supply chains. If Indian companies want to compete and integrate into these supply chains, the only way forward is through the utilization of contemporary technologies in their manufacturing processes and their overall supply chains.
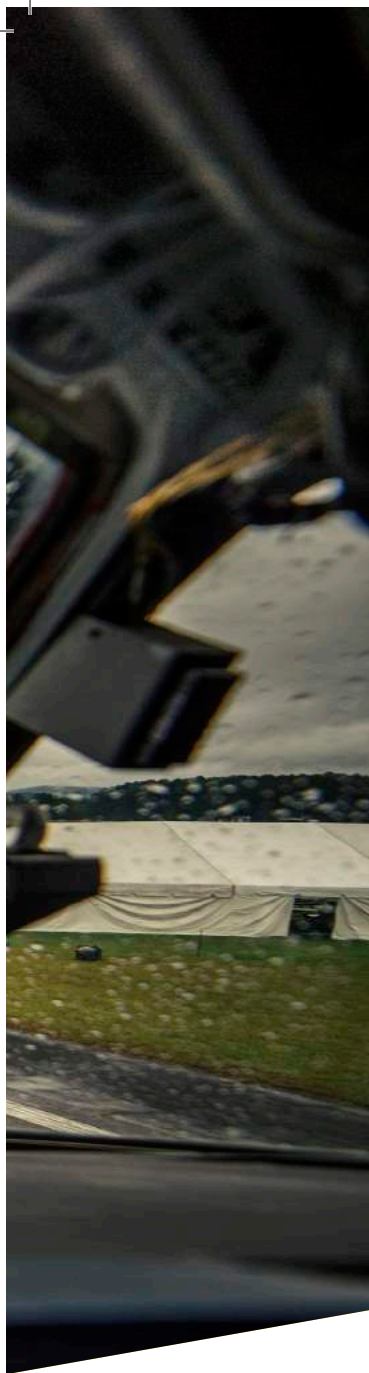
Contemporary technologies are here to stay and are likely to advance into even more cutting-edge iterations, creating a wider range of use cases. For India to truly achieve self-reliance in defence production and particularly if it wants to become a manufacturing hub, it is imperative to use the SP model and one of the associated segments/platforms as a stepping stone to integrate contemporary technologies into India's defence manufacturing process and supply chain.

Way forward

Contemporary technologies promise the intensification of modern-day war. This is because of the technology driver which is the human relationship with machines. As humans become increasingly absorbed in machines and vice versa, they begin a man machine symbiosis making machines more and more intelligent each day. AI/AR/VR now act as a collaborator for humans. The extensive programming to create algorithms for these systems is done by several programmers working on the same code with little or no knowledge about the program in entirety. For this, an impetus is being given to writing codes/programs to facilitate communication directly with the code's user and provide easy interaction between humans and non-human entities.

Contemporary technologies may soon begin proliferating throughout the military's decision-making. It may be used in intelligence analysis, strategic decision support, operational planning, command and control, logistics and weapon systems across all environments. If they are to be employed in future military programs, there is going to be a need of informed users, i.e., military personnel for their application and quality assurance. Only deep technical experts will be unable to address the issue completely. According to a UK government report[16] , any skilled workforce using AI should be a mix of those with a basic understanding, more informed users, and specialists with advanced skills. In the future, almost every personnel will need basic knowledge of application of these technologies and how to combine them with human intelligence.

It is an established fact that machines are better at assembling data and analyzing it (by finding patterns if needed). They react faster than humans and even operate other machines more efficiently. With machines becoming more intelligent, there is a need to balance the power of thinking and acting between humans and machines. For

example, when we use GPS for direction, we reduce our ability to remember and reason spatially which is a highly important skill specially in military. Use of contemporary technologies solves one problem but may end up creating a new one and hence in strategic partnerships it is a trade-off between exaggerating role of humans in war or exaggerating role of these technologies in war.

It is top priority for an armed force to provide a soldier with maximum data possible. The data needs to be processed into information and subsequently action. Equipping the soldier with AI/AR/VR is the facilitator to process this information overload.

Contemporary technologies will become inevitable in future warfare and India realizes the need to become the pioneer in the world when it comes to these technologies. For instance, for the last three years, the Centre for Artificial Intelligence and Robots (CAIR), DRDO, has been perfecting four different models of mobile robots designed to infiltrate military and combat zones, map the area and help friendly troops punch their way in. Two of these models were on display at the 107th Indian Science Congress. The Sentry is a four-wheeled robot which looks almost spider-like with a large central eye and a battery of sensors in front. The unit is designed to probe flat or semi-flat landscapes for the military. The second machine, called Mini-UGV is a squat, tracked robot resembling a large, toy tank designed to infiltrate buildings occupied by terrorists and survey the various floors. Both of these models are completely autonomous. Sentry is also capable of patrolling a medium-sized perimeter constantly for as long as the battery holds a charge. The maximum battery endurance of both machines is about four hours. Both systems use a multitude of sensors, including GPS, 360-degree cameras and an infrared sensor. The other model of robot is said to be a robot ball, called ballbot, which could be dropped by the mini-UGV across the various floors of a terrorist-held building, which would then be controlled by an operator from a remote location. The fourth machine is a larger reconnaissance ground vehicle which again has autonomous capabilities. Eight of these various robots are designed to operate as a team. Each robot has multi-agent collaboration. This means they can talk to each other. Both machines have completed testing and are ready to be deployed.[17] Such developments mark the beginning of a new digital era.

16   https://www.army.gov.au/our-future/blog/situational-awareness/the-new-reality-how-augmented-virtual-and-mixed-reality-will

17   http://www.indiandefensenews.in/2020/01/army-may-soon-get-robot-option-for.html

About ASSOCHAM

The Knowledge Architect of Corporate India

Evolution of Value Creator

ASSOCHAM initiated its endeavor of value creation for Indian industry in 1920. Having in its fold more than 400 Chambers and Trade Associations, and serving more than 4,50,000 members from all over India. It has witnessed upswings as well as upheavals of Indian Economy, and contributed significantly by playing a catalytic role in shaping up the Trade, Commerce and Industrial environment of the country.

Today, ASSOCHAM has emerged as the fountainhead of Knowledge for Indian industry, which is all set to redefine the dynamics of growth and development in the technology driven cyber age of 'Knowledge Based Economy'.

ASSOCHAM is seen as a forceful, proactive, forward looking institution equipping itself to meet the aspirations of corporate India in the new world of business. ASSOCHAM is working towards creating a conducive environment of India business to compete globally.

ASSOCHAM derives its strength from its Promoter Chambers and other Industry/Regional Chambers/Associations spread all over the country.

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As a representative organ of Corporate India, ASSOCHAM articulates the genuine, legitimate needs and interests of its members. Its mission is to impact the policy and legislative environment so as to foster balanced economic, industrial and social development. We believe education, IT, BT, Health, Corporate Social responsibility and environment to be the critical success factors.

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Currently, ASSOCHAM has more than 100 National Councils covering the entire gamut of economic activities in India. It has been especially acknowledged as a significant voice of Indian industry in the field of Aerospace and Defence, Auto and Auto Ancillaries, Arbitration & Legal Affairs, Corporate Social Responsibility, Environment & Safety, HR & Labour Affairs, Corporate Governance, Information Technology, Luxury and Lifestyle, Biotechnology, Telecom, Banking & Finance, Company Law, Corporate Finance, Economic and International Affairs, Tourism, MSMEs, Textiles, Civil Aviation, Infrastructure, Energy & Power, Education, Legal Reforms, Real Estate and Rural Development, Startups & Skill Development to Mention a few.

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