"DESIGN AND MAKE IN INDIA": MILITARY AIRCRAFT

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Make in India is a lion's step: its symbol is a lion made of cogs.[1]
Design in India is as important as Make in India[2].

— Narendra Modi,
Prime Minister of India

Make in India is an opportunity to make India truly and globally competitive[3].

— Cyrus Mistry, CEO Tata Group

INTRODUCTION

The Prime Minister of India, Narendra Modi's emphasis on the need for "Design in India" during the launch of the "Digital India Week" is a significant statement, which has the potential to take the "Make in India'"campaign to a higher level.[4] The Indian government, in an endeavour to give a major

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1. "Modi's 'Make in India' Campaign: Top 10 Quotes", September 25, 2015, http://www.business-standard.com/article/economy-policy/modi-s-make-in-india-campaign-top-10-quotes-114092500440_1.html. Accessed on July 2, 2015.
2. "PM Modi Launches Digital India Campaign: As it Happened", July 2, 2015, http://zeenews.india.com/business/news/technology/pm-narendra-modi-to-launch-digital-india-campaign-today_130358.html. Accessed on July 3, 2015.
3. n. 1.
4. "Digital India Week: 'Design in India' as Important as 'Make in India', says PM Narendra Modi", July 1, 2015 http://www.financialexpress.com/article/tech/digital-india-week-live-narendra-modi-all-set-to-launch-e-hospital-e-signature-more/92878/. Accessed on July 2, 2015.

About 60 percent of India's requirement of weapons is being met through imports. With an allocation of US$ 37.4 billion for defence and despite being the largest importer of arms, India has not been able to meet its defence needs and there are plans to spend INR 250 billion in the next 7-8 years on capital acquisitions.

push to its dream project "Make in India" in the defence sector, awarded 56 defence manufacturing permits to private companies in the last one year[5]. India, with 14 percent of international arms imports, was the largest importer of arms in 2014 with almost three times more share of the volume of the arms imports than the second placed China.[6] About 60 percent of India's requirement of weapons is being met through imports. With an allocation of US$ 37.4 billion for defence[7] and despite being the largest importer of arms, India has not been able to meet its defence needs and there are plans to spend INR 250 billion in the next 7-8 years on capital acquisitions.[8] The present government is trying hard to encourage "Make in India". The government has issued 56 licences to the private companies in the last one year, which is 48 licences more than the 8 licences issued during the last three years of the United Progressive Alliance (UPA) government.[9] The government had earlier allowed 49 percent Foreign Direct Investment (FDI) in the defence sector to support "Make in India".[10] There is a provision to allow FDI beyond 49 percent subject to clearance by the Cabinet Committee

5. Manu Pubby, "Boost to Make in India: Modi Govt Awards 56 Defence Licences to Private Cos Like Mahindra, Tata &Pipavav",*The Economic Times*, June 27, 2015, http://economictimes.indiatimes.com/news/defence/boost-to-make-in-india-modi-govt-awards-56-defence-licences-to-private-cos-like-mahindra-tata-pipavav/articleshow/47837004.cms. Accessed on June 29, 2015.
6 Rajat Pandit, "India's Arms Imports Almost Three Times of China, Pak", SIPRI Report, March 17, 2014, http://timesofindia.indiatimes.com/india/Indias-arms-imports-almost-three-times-of-China-Pak-SIPRI-report/articleshow/32190097.cms. Accessed on June 29, 2015.
7. Defence Manufacturing, http://www.makeinindia.com/sector/defence-manufacturing/. Accessed on June 30, 2015
8. Ibid.
9. Pubby, n. 5.
10. Sunitha Rai, "India Increases Foreign Investment Limits In Defense and Insurance Sectors To 49%," October 7, 2014, http://www.forbes.com/sites/saritharai/2014/07/10/india-increases-foreign-investment-limits-in-defense-and-insurance-sectors-to-49/. Accessed on June 30, 2015.

on Security on merit basis[11].

Most advanced nations have involved the private sector in the indigenous production of military aircraft. This played a key role in increasing defence aircraft production and improving efficiency. The private sector, with its efficiency and innovativeness, could become a key player in producing aircraft hardware and/ or components for the indigenous aircraft industry. However, the participation of the private sector in "Make in India" will also bring with it its inherent follies and vices. It may also bring with it cut-throat competition, an aspiration for higher profits and a desire for achieving higher sales targets in which the companies' profits may outweigh the nation's priorities. They may try to sell their products at all cost even if they are too expensive or do not meet all the user requirements. The government should factor in these issues while formulating policies and legal provisions.

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Post-graduate engineering and defence production courses at the MTech/ PhD level are needed to undertake Research and Development (R&D) in this niche field. The development of niche technologies, innovations and success of "Make in India" also require adequate expenditure on R&D. The India Air Force (IAF) is the predominant user of military aircraft among the three Services and, hence, has become its patron and plays an important role in guiding future military aviation indigenisation. This paper would study the role and impact of factors like knowledge base/higher education in aeronautics, privatisation, Public Sector Undertakings (PSUs), imports/ licensed production and indigenisation, R&D project ownership, fund allocation and tax incentives in order to make "Design and Make in India" in the defence aviation sector a success.

11. Press Note No. 7 (2014 Series), Subject, Review of the policy on Foreign Direct Investment (FDI) in Defence sector –amendment to 'Consolidated FDI Policy-Circular 2014'., August 26, 2014, http://dipp.nic.in/English/acts_rules/Press_Notes/pn7_2014.pdf. Accessed on July 8, 2015

HISTORICAL BACKGROUND

HAL: Hindustan Aircraft Limited was established by Shri Walchand Hirachand on December 23, 1940, at Bangalore.[12] It was placed under the Ministry of Defence in 1951 and renamed as Hindustan Aeronautics Limited (HAL) in 1964.[13] The HAL design team under the leadership of Dr VN Ghatage had successfully developed and manufactured many aircraft, including the HT-2 piston engine trainer, Pushpak and Krishak piston engine light aircraft, and HJT-16 "Kiran" jet trainer. These pioneers of HAL had laid the foundation of Indian aviation's R&D.

MARUT: FIRST INDIGENOUS SUPERSONIC JET FIGHTER

The IAF's first Indian Chief of Air Staff Air Marshal S Mukerjee's desire to indigenously develop Asia's first supersonic fighter jet aircraft in the 1950s and the support of the then Defence Minister Mahavir Tyagi, resulted in the development of the HF-24 Marut jet fighter aircraft by HAL. It was designed by a joint team of German and HAL engineers, led by Dr Kurt Tank, famous for building the Focke-Wulf aircraft for Germany during World War II. The HF-24 Marut first flew on June 17, 1961,[14] making India only the sixth country in the world after the USA, UK, USSR France and Sweden to build a supersonic jet aircraft.[15] It was believed to be the best airframe design of its time, with high survivability and excellent manoeuvrability, which were tested in the India-Pakistan War of 1971.[16]

The HF-24 Marut was designed with an expected thrust of 3,700 kgf to be provided by the afterburning Bristol Siddeley (later known as Rolls Royce) Orpheus 703 engine. However, without afterburners, its engine could only produce 2,200 kgf,[17] which was not adequate to meet the ambitious target of

12. "Our History", http://www.hal-india.com/Our%20History/M__111. Accessed on July 1, 2015.
13. Ibid. Accessed on July 13, 2015.
14. "HF-24, Marut", http://www.globalsecurity.org/military/world/india/marut.htm. Accessed on June 30, 2015
15. V Narayan, "Indian Aviation - HF-24 Marut, First Indian Designed Jet Fighter", January 22, 2015, http://www.team-bhp.com/forum/commercial-vehicles-india/159928-indian-aviation-hal-hf-24-marut-first-indian-jet-fighter.html. Accessed on July 1, 2015.
16. "HAL HF-24, Marut Fighter-Bomber (1967)", May 03, 2015, http://www.militaryfactory.com/aircraft/detail-page-2.asp?aircraft_id=366. Accessed on June 30, 2015.
17. Narayan, n. 15.

Mach 2.0 performance, hence, restricted its employment as an interceptor.[18] India missed a golden opportunity when it did not accept the Bristol offer of joint development of the afterburner for the Orpheus 703 engine at a cost of Rs 5 crore.[19] The Marut, with its thin and swept wing, and providing high acceleration and manoeuvrability, and low landing speed was best suited for the interceptor role. It was one of the finest designs of its era and its ability to ferry at 40,000 ft with 0.9 Mach made it the fastest aircraft in the IAF's history.[20] In all, 147 Maruts were built before this dream project of an indigenous jet fighter aircraft was shelved in 1985.[21]

The curtailed lifespan of the legendry Indian fighter aircraft HF-24 Marut can be attributed to various factors, which include the reluctance of the leading defence manufacturers of the era to share advanced engines technology, sanctions imposed on India post the Pokhran nuclear blast in 1974, apprehension in India about a possible aggression by Pakistan in the late 1970s, depleting strength of IAF fighters, high expectations from the Marut, and advanced aircraft offered by the leading defence aircraft manufacturing countries.

Marut as a Future Fighter: The Marut is a proven design with a Mach 2.0 airframe. Its airframe could be explored for future medium range fighter aircraft. The revival of the Marut may appear to be a far-fetched idea but should not be ruled out. Aviation history has shown that many nations have continued to use proven airframe designs of the 1950s with suitable modifications, superior engines and avionics upgrades. The experience gained in designing the Light Combat Aircraft (LCA) should be used in refining the proven Marut design into a full-fledged combat aircraft. The Kaveri engine, with a dry thrust of 52 kN (5,302 kg) and afterburning thrust of 81kN (8,260 kg)[22] may not fully meet the requirement of the LCA, but, it could prove to be the right option for the Marut airframe.

18. n.14.
19. http://defencesecurityindia.com/aerospace-2/. Accessed on July 1, 2015.
20. Ibid.
21. n.14.
22. "Kaveri", http://www.drdo.gov.in/drdo/English/index.jsp?pg=kaveri.jsp. Accessed on July 1, 2015.

GRADUATING TO "DESIGN AND MAKE IN INDIA"

The government has shown its intent to support its "Make in India" campaign by reviewing old policies, and has issued licences, brought in transparency and expedited decision-making. The indigenous production of military aircraft is the key area for the "Make (rather Build) in India" campaign to bring down the huge import bill. However, it is quite unlikely that any country would agree to build a military aircraft with its niche technologies to be built in India. These niche technologies are impossible to acquire and would need to be developed with indigenous effort. R&D would be crucial in designing and producing military aircraft indigenously. This field also has the potential to become a major source of revenue through export in the long run.

BOOST TO PRIVATISATION

The government certainly wants to bring down the import bill and strengthen indigenous industry in this critical sector. It has taken some key steps for easing the licensing norms to encourage the participation of the private sector in defence production. The Department of Industrial Policy and Promotion under the Ministry of Commerce and Industry, in its annual report, has highlighted key initiatives in encouraging "Make in India" in the defence sector. These initiatives include exempting some of the dual use items from the defence angle licensing requirement, finalisation of the process for the industrial licence for the manufacture of Unmanned Aerial Vehicles (UAVs), removal of the restriction on annual capacity, and permission to sell defence items to other government entities.[23] The moves would give a boost to the participation of the private sector in defence production. These initiatives and speedy licence clearances are indication of the government's willingness to provide the private sector with a level playing field which till now was the exclusive domain of the public sector entities and foreign vendors. These initiatives should help build a proper

23. "Department of Industrial Policy and Promotion", Ministry of Commerce & Industry New Initiatives, Schemes & Programmes during the First Year of NDA Govt, http://dipp.nic.in/English/News/new_Initiative_NDA_ Government_03June2015.pdf. Accessed on June 29, 2015.

aerospace industry ecosystem comprising a large number of component and sub-component suppliers feeding their output in stages to the final integrators. It is a win-win situation for all—the Indian industry, the major suppliers of the world and the Indian government.

Vices of Privatisation: The Boeing Company had bribed and given favours to then Principal Deputy Assistant Secretary of the US Air Force (USAF) for Acquisition and Management, Darleen A Druyun to obtain information about competitors for procurement contracts worth billions of dollar from the USAF and National Aeronautics and Space Administration (NASA).[24] She was later employed as the vice president of Boeing after her retirement in 2002. The names of big players and high ranking officials seeking favours/ kickbacks in arms deals by US companies were also brought to public notice in another expose.[25] These incidents clearly bring out the influence that the arms industry enjoys in the United States and other countries. There have been many instances wherein the arms industry has put its weight behind certain senators in order to get favourable policy decisions from the US Senate. The arms industry stakeholders have made inroads into both the Democratic and Republican Parties of the United States. The key stakeholders of the arms industry held major policy-making positions in the Bush Administration and were key contributors to channelising the spending on defence.[26]

The vices of privatisation are also visible in India. The private sector, along with its efficiency, has brought in inflated prices and other vices. It is common knowledge that many powerful industrial houses which have been providing certain services on the behalf of the government agencies over a period of time, have monopolised certain sectors. They have been found wanting in providing the quality of service which was expected of

24. "Boeing to Pay United States Record $615 Million to Resolve Fraud Allegations", June 30, 2006, http://www.justice.gov/archive/opa/pr/2006/June/06_civ_412.html. Accessed on July 1, 2015.
25. Eric Lipton, Nicola Clark and Andrew W Lehren, "Diplomats Help Push Sales of Jetliners on the Global Market", January 2, 2011, http://www.nytimes.com/2011/01/03/business/03wikileaks-boeing.html?pagewanted=all&_r=0. Accessed on July 1, 2015.
26. William D Hartung and Michelle Ciarrocca, Report: "Ties that Bind: Arms Industry Influence in the Bush Administration and Beyond", October, 2004,http://www.worldpolicy.org/projects/arms/reports/ TiesThatBind.html. Accessed on June 30, 2015.

To add to the woes, the defence PSUs were grappling with cost overruns and time delays. The inefficiency and lack of accountability of the defence PSUs were some of the reasons for the delayed timelines and cost overruns.

them. There are reports that there have been attempts to influence certain decision-makers in order to get favourable decisions in policies or to win contracts.[27]

CRITICAL ROLE OF PSUs

India's focus on R&D, a key ingredient of "Design in India" in military aircraft has been, at best, average to moderate in the past. The initial gains made by our forefathers in "Design in India" in military aircraft were lost due to the shifting of focus to "Build (read assemble) in India" under the assurance of getting new technologies.[28] To add to the woes, the defence PSUs were grappling with cost overruns and time delays. The inefficiency and lack of accountability of the defence PSUs were some of the reasons for the delayed timelines and cost overruns. The other factors that hindered indigenisation include lack of a long and term policy-funding support, failure to export, and reluctance to involve the private sector. The depleting inventory of weapons has often created concerns among the armed forces, resulting in greater reliance on import of arms. There appeared to be a lack of trust in the PSUs due to their inability to deliver defence equipment in a given timeframe and cost.

The above factors are too simplistic to explain the less than optimum performance of the PSUs. It would be prudent to study a little more in depth the R&D process, policy decisions, timelines and funding involved in this critical sector to draw the correct lessons. The time involved in development of key technologies, especially military aircraft, is huge. The MiG-21 aircraft, developed by the erstwhile USSR (now Russia) and the F-16 by the US in the early 1960s continue to be their flag bearers even after

27. Siddharth Thacker, "India: Bribery & Corruption", http://www.globallegalinsights.com/practice-areas/bribery-and-corruption/global-legal-insights---bribery-and-corruption-2nd-ed/india. Accessed on July 3, 2015.

28. "Light Combat Aircraft: Need for Course Correction" I, December 8, 2014, http://www.stratpost.com/light-combat-aircraft-need-for-course-correction-i. Accessed on July 12, 2015.

50 years. The development of niche defence aircraft technologies takes time and needs nurturing by the government and the armed forces. The F-22 Raptor, the most advanced fighter aircraft ever developed by the US too has faced many glitches and failures. It has exceeded all the time and cost estimates. However, the failures of these machines are not brought into the public domain by their governments/ companies and only successes are highlighted in the media to win contracts and create an impression of their invincibility. The Indian aircraft industry and R&D organisations too need to be supported in their endeavour if we have to achieve self-reliance in defence technology.

Higher studies and research in the aerospace and defence production domains are important for the development of cutting edge technologies. There are some colleges and Indian Institutes for Technology (IITs) that are offering aerospace engineering courses.

CHALLENGES FOR "DESIGN AND MAKE IN INDIA"

Knowledge Base: A Key Pillar Missed Out

The government has identified 25 key thrust sectors for "Make in India", which include aviation, defence manufacturing and space. The four pillars of the "Make in India" initiative are new processes, new infrastructure, new sectors and new mindset. The government report could have included another pillar for the success of "Make in India" i.e. "new knowledge base". The Defence Research and Development Organisation (DRDO) has identified 26 critical defence technologies and test facilities, which it aims to acquire through offsets and which need immediate attention.[29] These areas need to be included in the curriculum of the technical universities if India has to become a leader in defence technology.

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29. http://www.drdo.gov.in/drdo/English/List_of_Critical.pdf. Accessed on July 13, 2015.

aerospace engineering courses. However, there is no university in India which is dedicated to aerospace and defence production studies. There are many courses on industrial production, but defence production is not being offered as a subject. The defence production engineering and aviation tool design are specialised fields and need to be included in the aerospace universities. If India has to become a major R&D and defence production hub and achieve Prime Minister Narendra Modi's goal of "Design in India", it would have to provide advance training to its engineers and future leaders in these niche fields.

China, aspiring to become a leader in aerospace technologies, had set up Beihang University[30] and Nanjing Aeronautics and Astronautics University as early as in 1952 to support aerospace R&D.[31] These universities provided China the necessary knowledge base and work force, and encouraged research and development to support "Make in China". Though the Chinese were initially branded as imitative, they continued to improve their indigenous capability. They are now not only building transport aircraft, helicopters, fighters, UAVs and other defence equipment but are also supplying these to other countries. Most advanced countries have similar universities, colleges and courses to encourage higher studies and R&D in aerospace technologies.

Creation of Aerospace and Defence Technology University: Higher studies in the fields of aerospace and defence technology need to be given a push. India could consider setting up a dedicated "University for Aerospace and Defence Technology". This university would provide the necessary knowledge base and trained engineers to encourage R&D and defence production in India in order to achieve "Design and Make in India". This would also facilitate easier absorption of advanced aviation and defence technologies from other countries. The Indian National Defence University (INDU) could also include M Tech and PhD courses in higher studies on aeronautical engineering, systems integration and reliability and critical areas identified by the DRDO.[32]

30. http://ev.buaa.edu.cn/about_buaa/index.htm. Accessed on May 22, 2015.
31. http://iao.nuaa.edu.cn/. Accessed on May 22, 2015.
32. http://www.drdo.gov.in/drdo/English/List_of_Critical.pdf. Accessed on July 13, 2015.

HURDLES TO INDIGENISATION

Delay, Deny and Destroy: The leading arms supplying nations and their companies try every weapon in the armoury and exercise every option to ensure that prospective buyers get addicted to their products and do not develop indigenous capabilities[33]. Delay, Deny[34] and Destroy is the *mantra*. The leading arms suppliers sell advanced weapons at exorbitant costs. Limited transfer of technology is offered in order to dissuade/ delay indigenous development of similar technologies. The transfer of technology is often limited to assembly of arms, production of low end technology spares and carrying out of servicing, etc. High end technology is denied on some pretext or other. The import of advanced aircraft often pushes indigenous projects to the back seat. Technology denial, escalating costs and time overruns often make indigenous projects unviable, thus, resulting in their shelving (destruction).

Perception Wars: The suppliers also try to influence perceptions by highlighting weaknesses in the indigenous developmental projects in order to dissuade target buyer countries from continuing R&D in the niche defence aviation fields. However, what they do not reveal is that their own R&D had faced similar challenges while designing and producing these advance flying machines. The failures and challenges faced by the US, Russia, China, Israel and other advanced countries, though well documented, are not overtly accepted by these suppliers.

Transfer of Technology and Offsets: Japan, one of the closest allies of the US after the UK, has faced hefty premiums for limited Transfer of Techonolgy (TOT) and stringent licensed production norms followed by the US in order to safeguard its technology.[35] It is even concerned about the likely risk of overdependence on the US in co-development projects. The

33. "Self-Reliance in Land Systems Through Indigenisation: The Future Perspective", April 30, 2014, http://www.claws.in/event-detail.php?eID=419. Accessed on July 2, 2015.
34. "Dependence of Aeronautics R&D Projects on Foreign Sources", May 12, 2015, http://www.defense-aerospace.com/articles-view/release/3/163712/india-confronts-lack-of-advanced-materials-for-aerospace.html0 Accessed on July 2, 2015.
35. Christopher W. Hughes, "The Slow Death of Japanese Techno-Nationalism? Emerging Comparative Lessons for China's Defense Production", http://www2.warwick.ac.uk/fac/soc/pais/people/hughes/ researchandpublications/articles/hughes_the_slow_death_of_japanese_techno-nationalism_jss_june_2011.pdf. Accessed on July 2, 2015.

insistence of the Chinese to honour the ToT agreements was portrayed by Western analysts as win-win for Chinese, meaning the Chinese would win twice[36]: it is a matter of survival for their defence industry as well as long-term business opportunity for them. Payment of bribes, influencing key stakeholders and other unfair means are resorted to for getting lucrative contracts.[37] Offsets are used for paying bribes and inflating the costs.[38]

Licensed Production: The supply of modern arms comes at an exorbitant cost and often results in dependence on the suppliers.[39] The acquisition of the MiG-23 fighter aircraft from Russia to meet the Tactical Air Strike Aircraft (TASA) requirement meant an end of the Marut.[40] As a follow-up, the Indian policy-makers decided to opt for licensed production (read assembly) of fighter aircraft acquired from foreign vendors. Licensed production gave India the required equipment as an interim measure but did not give it the indigenous capability and ability to produce the equipment. Though licensed production (assembly) had a few benefits, it impacted Indian R&D in aviation adversely and resulted in slowing down of India's indigenisation process. The Marut was a promising aircraft design; however, various prototypes built by HAL were shelved.

FUNDING FOR R&D

With $40 billion earmarked for R&D, India is expected spend about 0.9 percent of the Gross Domestic Product (GDP) during 2015-16 against 2.5 to 3 percent being spent by most advanced countries. This is much less than the target of 2 percent set by the Indian government in 2010, which

36. "China's Drive for 'Indigenous Innovation: A Web of Industrial Policies", https://www.uschamber.com/sites/ default/files/legacy/reports/100728chinareport_0.pdf. Accessed on July 2, 2015.
37. "Guns and Sugar", May 25, 2013, http://www.economist.com/news/business/21578400-more-governments-are-insisting-weapons-sellers-invest-side-deals-help-them-develop. Accessed on July 2, 2015
38. "Taiwan's Frigate Corruption Investigation:Can They Collect?", April 17, 2014, http://www.defenseindustrydaily.com/full-steam-ahead-for-taiwan-frigate-corruption-investigation-01546/. Accessed on July 2, 2015.
39. "Arming India into Dependency", January 14, 2014, http://www.thehindu.com/opinion/lead/arming-india-into-dependency/article5574316.ece. Accessed on July 2, 2015.
40. n. 4.

was reiterated in 2012.[41] The spending on R&D has fluctuated between 0.6 to 0.8 percent in the last two decades, which explains the low level of innovation and slow development of new technologies[42]. The spending on R&D is a mirror which indicates innovations and progress. China, which was spending about 0.6 percent on R&D in 1996, steadily increased it to 2 percent in 2012.[43] The urgency shown by the government in giving licences to private sector entities would need to be followed by raising the budget allocation for R&D to about 2 percent. The government could also consider giving tax incentives to the companies involved in R&D. These measures would provide a boost to the development of aviation projects and in achieving the goal of "Make in India".

Future of "Design and Make in India"

The discontinuation of the manufacture of the Marut aircraft brings us to the key issue, which is that the development of indigenous engines is a prerequisite for the indigenous aerospace programme. China, despite its success in the aviation field, is grappling with lack of engine technology and has invested a huge amount of money in the development of next generation engines. Nobody in the world is going to share critical technology. The Indian Space Research Organisation (ISRO) had faced the same problem when India was denied the cryogenic engine for its space programme. However, ISRO had the support of the establishment, which was crucial for success. The Indian establishment has to stand behind Indian defence R&D organisations in achieving this national goal of indigenisation of the defence aviation industry. It must be a given that the Aeronautics Development Agency (ADE), Gas Turbine Research Establishment (GTRE) and other organisations of the DRDO would take the ownership and deliver.

41. Vikram Doshi and Vijay Gilde, "Budget 2014: Govt Should Extend Incentive to Boost R&D Activity in India", June 23, 2014, http://businesstoday.intoday.in/story/budget-2014-incentive-needed-to-boost-randd-activity-in-india/1/207478.html. Accessed on June 30, 2015.
42. http://www.tradingeconomics.com/india/research-and-development-expenditure-percent-of-gdp-wb-data.html. Accessed on June 30, 2015
43. "Research and Development Expenditure (% of GDP)", http://www.indexmundi.com/facts/indicators/GB.XPD.RSDV.GD.ZS/compare#country=cnm. Accessed on June 30, 2015.

The IAF, with its trained engineers and aviators, could provide valuable design inputs to the defence aviation R&D agencies during the aircraft/ systems design and development phase.

Ownership Issues

The success of indigenous R&D requires that users take over the ownership of R&D projects. The active role of the users in these projects has been highlighted by many armed forces experts.[44] Most countries involved in designing defence aircraft ensure that one of the three arms of the armed forces takes the ownership of defence aviation design and development projects. They provide design inputs and specialist advice to the aircraft design and developing agencies. The military R&D or military supported R&D and government agencies have played a key role in the development of fighter and bomber aircraft in the US.[45]

Design and Development: The Indian Navy celebrated 50 years of the "Made in India" campaign on September 25, 2014.[46] The Indian Navy's Department of Naval Design (DND) has a strength of 350 uniformed officers. These officers have been trained at Indian Institutes of Technology (IITs) and equivalent institutions of the world and are playing a stellar role in design, development and construction of naval ships/ submarines in India.[47] They have made significant contributions in the indigenisation/ "Make in India" campaign, and in saving enormous amounts of the taxpayers money.

The IAF, with its trained engineers and aviators, could provide valuable design inputs to the defence aviation R&D agencies during the aircraft/ systems design and development phase. The IAF's Base Repair Depots (BRDs), with their experienced, qualified and competent engineers and technicians have vast experience in indigenisation and could prove to

44. M Matheswaran, "Aerospace", http://defencesecurityindia.com/aerospace-2/. Accessed on July 1, 2015.
45. http://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR939.pdf. Accessed on July 1, 2015.
46. Gulshan Luthra and Cmde Ranjit Rai, "Navy's Made in India Campaign Marks 50 Years Naval Design Bureau Celebrates Golden Jubilee", October 2014, http://www.indiastrategic.in/topstories3538_Navy_made_in_India_campaign_marks_50_years.htm. Accessed on July 2, 2015.
47. Ibid.

be a valuable asset. The BRDs have done an exceptional job in sustaining outdated systems, some of which had been abandoned even by the Original Equipment Manufacturers (OEMs). The expertise obtained in sustaining the legacy systems by the BRDs could be utilised in further indigenisation of the systems. They have played a key role in the life extension of some equipment, thereby, reducing the cost of maintenance and saving precious taxpayers' money. Their innovations and contributions in indigenisation of critical components are well known. They could be upgraded to act as laboratories for testing and refining technological innovations. These could be upgraded as Centres of Excellence for in-house R&D and indigenisation. The in-house R&D could include upgradation/ replacement/ modification of existing systems/ software/ support systems, etc. Systems other than aircraft being purchased are equally expensive and there is a need to formalise an evaluation process similar to the one followed in aircraft evaluation, and BRDs could help in achieving this.

The IAF's Aircraft Systems and Testing Establishment has played a significant role in evaluating flying machines during the development phase. However, the IAF does not have a separate directorate for aircraft design and development.

The human resource is one of the IAF's invaluable assets. Many engineers have excelled in their M Tech. The technical expertise obtained in higher courses like M Tech needs to be optimally utilised. The best way to utilise these experts is by using them in a directorate involved in the formulation of Air Staff Qualitative Requirements (ASQRs), TEC, field trials and BRDs. The post course utilisation and project-based tenures could prove useful in utilising their expertise.

The IAF's Aircraft Systems and Testing Establishment has played a significant role in evaluating flying machines during the development phase. However, the IAF does not have a separate directorate for aircraft design and development. Defence aviation is a specialised field in which the IAF is the only agency in India which has vast experience and expertise. The IAF could consider establishing a Directorate of Aircraft and System Design

and Development (DASDD), having a large number of highly qualified engineers. The DASDD and BRDs together could prove to be an invaluable asset for the IAF. The DASDD could chalk out a plan for the engineering officers to undergo M Tech and PhD courses in aeronautical engineering, advanced metallurgy, system integration and reliability, etc. in universities in both India and abroad, in order to have adequate in-house expertise to give inputs on design and development aspects. This would facilitate integration of users and R&D agencies for niche aviation technologies.

DEVELOPMENTAL DILEMMAS

The development of niche technology in a denial regime is a difficult and time consuming process, involving innovation, testing and trials. The evolution of technology is dynamic, which keeps improving with time and is fraught with the risk of obsolescence. By the time you achieve one technology milestone, the world has moved to another and, thus, this needs regular improvements/ updates. However, if you develop one technology and continue improving it, it may become a source of regular income as well as self-reliance. The initial MiG-21 and F-16 built by the USSR and USA respectively were quite elementary compared to the advanced versions being flown today. Therefore, it would be prudent for the users to decide a stage at which to freeze the Qualitative Requirements (QRs) for a certain number of aircraft in order to allow a development timeframe for the enhanced capabilities sought by the users in the process of development. There is need for the users to consider induction of a certain number of aircraft on realistically acceptable QRs till the aspired QRs are met.

ACQUISITION DILEMMAS

The exorbitant cost of acquisition of modern fighter aircraft could have been one of the factors responsible for the Indian government going slow, and importing these aircraft in large numbers in order to reach the desired strength of 45 squadrons. The number of fighter squadrons required for a two-front war would be even higher and the cost of acquisition of such a large number of fighter aircraft from a foreign vendor would be significantly

higher, thus, may not be a financially viable option for any government. The procurement of indigenous aircraft would mean that the money is being invested within the Indian economy and would result in more jobs for the Indian people. The government would be more willing to buy indigenous aircraft in large numbers rather than importing from foreign vendors.

The arrival of the private sector, and the increased focus of the government on indigenous R&D and "Make in India" would put pressure on the PSUs to perform. As a result, the IAF would become the beneficiary. Therefore, the best way to meet the depleting strength of fighter squadrons would be to acquire a limited number of cutting edge technology fighter aircraft from foreign vendors and give a push to the manufacture of indigenous fighter aircraft. The combination of cutting edge fighter aircraft from foreign vendors through co-development or co-production or limited technology transfer, alongwith a large number of indigenous aircraft could help increase the IAF fighter squadron strength to the desired level.

A WAY AHEAD

The issues crucial in achieving the prime minister's goal of "Design and Make in India"[48] include restructuring higher education in aerospace and defence technologies, private sector participation, greater accountability of PSUs, ownership by the users, increasing expenditure on R&D, favourable policies, and a supportive leadership. The government could consider including the "New Knowledge Base" as one of the pillars for the success of its ambitious "Design and Make in India" campaign. The establishment of an "Indian Aerospace and Defence Technology University" could play a key role in imparting world class higher education in niche aerospace and defence technology fields.

The boost given to the private sector companies by the Indian government in the last one year was a much awaited and much needed incentive. The disadvantage faced by the Indian private sector vis-à-vis foreign suppliers would hopefully reduce to a large extent. The new polices related to licensing

48. "Modi Asks Youth to Innovate and 'Design in India'", July 2, 2015, http://www.business-standard.com/article/current-affairs/modi-asks-youth-to-innovate-and-design-in-india-115070200056_1.html. Accessed on July 2, 2015.

and defence equipment are expected to make defence production a more financially viable sector. It is now up to the private sector to take the lead and plunge into the lucrative high risk sector.[49] However, there is a need to understand that any new system brings with it both good and bad practices. Sometimes, new initiatives do not produce the desired results because the policy-makers only factor in the good aspects, and not the associated flaws and vices. Therefore, there is a need to include these factors in the policies and provide suitable legal protection measures.

A healthy combination of the private sector and PSUs could bring out the best of both. The private sector can be a key contributor in the defence production industry with its competitiveness, efficiency, cost consciousness and innovativeness. The PSUs can deliver in the R&D sector with government support, increased funding, improved efficiency and greater accountability. They can play a critical role in balancing the monopolistic attitude of the private sector and in monitoring the quality of the defence products being produced and supplied by the private sector. The government needs to factor in these key aspects in the policies related to defence R&D and production. It should provide suitable legal provisions to protect the taxpayers' money and prevent any likehood of exploitation by private players.

The IAF will always be a key player in the aerospace domain of the defence sector. It may have to take the initiative in, and ownership of, aviation design and development, as was shown by India's first Air Chief S. Mukherjee, to steer the indigenisation process and "Make in India". The setting up of the Directorate of Aircraft and Systems Design and Development (DASDD) and making IAF engineers undergo M Tech/ PhD courses in the aerospace and defence technology related subjects could help in gaining in-house experts to support indigenous design and development of niche defence aviation technologies. The upgradation of the BRDs could provide the IAF with the R&D Centres and Centres of Excellence in their respective area of specialisation.

49. "Northrop F-20 Tigershark Multi-Role Fighter Aircraft (1982)", July 2, 2014, http://www.militaryfactory.com/aircraft/detail.asp?aircraft_id=688. Accessed on July 2, 2015.

The impetus to indigenous R&D and defence production could be provided through raising the budget allocation for R&D from the existing 0.9 percent to 2.0 percent of the GDP and by giving tax incentives to the companies involved in R&D. This does not mean that there is no place for technology transfer and collaboration. Indigenisation, collaboration, technology transfer and acquisition would go hand in hand till India achieves self-sufficiency.

The by-products of setting up the Aerospace and Defence Technology University are likely to be beneficial for indigenisation and creating a source of revenue for the government in the long run.

CONCLUSION

The deficiency in aviation and defence equipment for the Indian armed forces and the rising imports bills are major concerns for India. The proactive policies followed by the government to give a push to the participation of the private sector in "Make in India" in defence equipment needs to followed by the private sector stepping forward and taking the lead to support this initiative. Some of the big industrial houses like Mahindra, Tata and Reliance, already have subsidiary companies dealing with defence equipment. However, they were cautious in the past due to the restrictive policies. They now have an opportunity to exploit the window offered by the government with 49 percent FDI, issuing of licences, relaxation of production and sale restrictions, and the call for "Make in India". They could look for partnerships with global leaders in military aviation as well as exploit India's inherent strengths in Information Technology (IT) and other fields to enter this area. They could also utilise the expertise available with DRDO and other defence PSUs to take it to higher levels.

The PSUs would continue to play an important role in carrying out R&D in the niche aerospace and defence technology fields. They may now have to complete with the private sector. Suitable policies and legal provisions would make India's transition from the public sector to the multi-sector military aircraft market a smooth affair and prevent the possibility of

monopolisation and exploitation by the private sector/foreign vendors.

The by-products of setting up the Aerospace and Defence Technology University are likely to be beneficial for indigenisation and creating a source of revenue for the government in the long run. The Chinese had realised the importance of higher level education in aerospace design and development and set up many aerospace universities as early as in 1950, to embark on the journey of indigenisation. Their indigenous capability to undertake R&D and production of defence equipment, especially military aircraft, has improved tremendously since then. Sales of defence equipment have become a major source of revenue.

The enhancement of funding for R&D to 2 percent would provide the required impetus and flexibility to pursue indigenous projects. The setting up of a DASDD, upgrading BRDs and taking over the ownership of military aircraft R&D projects could give the required impetus to indigenous industry. The prolonged development timeframes necessitate that indigenous projects are persisted with. The feasibility of induction of indigenous aircraft on achieving the minimum acceptable QRs needs consideration and may well prove to be a key contributor to replenish the depleting aircraft squadron strength. It would also allow time for further R&D till the desired QRs are achieved.

Lastly, the "Make in India" concept offers the arms supplying nations and leading companies an opportunity to collaborate and benefit in the long run. The high volumes of business make it an attractive option for them. There is a need to simultaneously strengthen indigenous R&D and defence aircraft manufacturing capabilities. The higher timeframe involved in building indigenous R&D necessitates that a combination of acquisition, collaboration and indigenisation is followed. This could prove to be the best recourse to meet our defence needs as well as for the success of the "Design and Make in India" mission.