GENESIS AND EARLY GROWTH OF THE INDIAN AIRCRAFT INDUSTRY

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INTRODUCTION

Aircraft industries showcase the high technology capability of countries. Since its advent in the early 20th century, aviation has been a very high technology area of operation. Utilisation of aircraft in warfare has changed the manner in which wars are fought. Over time, military aviation has evolved to become the decisive instrument of the military power of a nation. Apart from military operations, aviation has become a major factor in delivering efficiencies to modern economies through increasing the effective utilisation of factors of production and other resources. Modern aviation equipment being of cutting edge design and incorporating very advanced technology, is quite expensive. Therefore, most advanced nations that have the wherewithal have invested in building robust domestic aviation industries. Apart from the cost of importing equipment, nations have found that despite the high cost, the imported aviation equipment often comes with political, economic, and strategic strings attached. Therefore, all nations that aspire towards great power status require putting in place an effective domestic aircraft industry. The world trade in aviation equipment is worth over several tens of billions of dollars annually. This gives further incentive to nations to commence export of aviation equipment apart from the geo-political advantages that this confers upon exporting states.

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Just as the invention of gunpowder led to the development of the armaments and firearms industry, the invention of flying machines led to the development of the aircraft industry, and as technology progressed further, to the aerospace industry.

BIRTH OF MODERN AVIATION

European efforts of research into the science of fluid dynamics by Otto Lilienthal, Sir George Cayley and Bernoulli amongst others led to the development of the science behind aviation. This science led the less scholarly but more technically and mechanically minded men to attempt to apply the then new theory into practice towards the development of mankind's first heavier than air flying machines capable of carrying human beings aloft this side of mythology. These efforts finally bore fruit with the Wright Brothers' flight of 12 seconds duration over 120 ft on December 17, 1903, at

Kitty Hawk in Flyer 1, ushering in the modern aviation age.

The Great War in Europe forced the European countries to seize the lead in military aviation from the US. Many major advances were made by European military aviation due to the pressures of war. In contrast, in 1913, the US Army Air Corps (USAAC) had just six active pilots and the whole of the US had less than 170. However, not forced to divert resources towards war on the scale that the Europeans were, US *private entrepreneur companies* (emphasis added), led by Glen Hammond Curtis and James Smith McDonnell and Donald Wills Douglas (unrelated Scottish immigrant MIT graduates),¹ to name a few, established the US industry on its own feet, leading to several landmark achievements. One such achievement was the first trans-Atlantic flight by the US Navy flying boat NC4 and the first trans-global flight by the Douglas world cruisers². Just as the invention of gunpowder led to the development of the armaments and firearms industry, and as technology progressed further, to the aerospace industry.

^{1.} Information from web page http://en.wikipedia.org/wiki/McDonnell_Douglas last accessed on March 3, 2014.

^{2.} Air Mshl SR Deshpande, *Aerospace Industry* (New Delhi: Manas Publications, 2004), pp. 25-28.

IMPORTANCE OF AEROSPACE POWER.

From its initially humble beginnings in the early years of the 20th century, aviation technology has grown by leaps and bounds, and in modern warfare, it has come to occupy a central position in the armed forces of all major powers. Even the People's Republic of China's (PRC's) People's Liberation Army (PLA), that for years followed the people's war concept, based predominantly on massed land forces, with air power in a defensive and supporting role, has in view of the obvious Air power has some unique characteristics that have contributed to its coming to occupy a predominant position in a country's military capabilities.

primacy of aviation in modern military operations placed the PLA Air Force (PLAAF) at pole position in its modernisation efforts.³ The PRC has also, in view of the acknowledged importance of air power to its Comprehensive National Power (CNP), invested heavily in its aircraft industry in both the military and civil sectors.⁴ Air power has some unique characteristics that have contributed to its coming to occupy a predominant position in a country's military capabilities. Some important and unique characteristics of air power that make it so important to a country's overall national power are as follows:

- Very Rapid Response: Aircraft typically travel at speeds of several hundred kilometres per hour (kmph) as compared to, at best, a few tens of kmph for land and maritime vehicles, giving ability for rapid application of force, including insertion of troops and supporting material.
- Ability to Circumvent Surface-Based Obstacles: This capability comes from the very nature of aerial vehicles that are built to travel through the medium of the air and, hence, over and above surface obstacles—note the air bridge from India to China over the Himalayas (a formidable natural obstacle) maintained by the US Air Force (USAF) during World War II to supply the Nationalist Chinese forces fighting the Imperial Japanese and the Berlin airlift to supply and maintain the Western forces and population in West Berlin which city had at the time been besieged

^{3.} KW Allen, G Krumel, JD Pollack "China's Air Force Enters the 21st Century" RAND Corporation Report from Project Air Force, 1995, pp. xvi-xxi.

^{4.} Information from webpage article "ARJ21 Regional Jet Aircraft, China" at http://www. aerospace-technology.com/projects/arj21/. Accessed on March 5, 2014.

by the Communist Soviet Union's armed forces, circumventing a manmade obstacle in this latter instance at the end of World War II and the beginning of the Cold War.

- Long Reach: This capability obtains by virtue of the long operational • radius of suitably designed aircraft which can be extended further through the use of air-to-air refuelling. Note the deployment of IAF Jaguar and Su-30 fighters to the continental US for exercises demonstrating the long reach of modern fighters that could deliver weapons to distant targets as well as deploy for specific peaceful purposes. Bombers and transport aircraft, the latter very similar to commercial airliners with which they share some technology, have consistently demonstrated their global range since the early years of air transport operations with useful payload. This long range large payload carrying capability has been increasing apace with advancements in aviation technology. The extreme example of this increase in large load carriage capability is the Soviet era An-124 "Ruslan" large transport aircraft which can carry up to 150 tonnes of payload over global ranges and is exceeded only by the Soviet An-225 "Mriya" which can carry a payload of a mind boggling 250 tonnes over global ranges⁵.
- Precision Strike Capability: The precision strike capability of air power has been available since the early years of aviation. The difference today is that while in earlier, less technologically advanced years, precision strike capability dwelt in the pilot, this capability has progressively moved to be incorporated in the machine itself. In earlier times, the pilot's skill overcame the existing limitations of technology to achieve the required precision as in the case of air-to-air kills during World War I and World War II, including the precision strike capability of the Royal Air Force's (RAF's) 617 Squadron, the "dam busters" that specialised in precision attacks to destroy targets of great value (dams of importance to the Nazis) and the specialised target locating and marking for attack by other bombers by "pathfinder" units⁶ within Nazi held territory in Europe in order to further the allied war effort till the late 1960s, with pilots using little more than ring and bead sights till more

^{5.} Details of the aircraft available at webpage http://www.aviastar.org/air/russia/an-225.php. Last accessed on March 15, 2014.

^{6. &}quot;Dambursters", http://www.dambusters.org.uk/. Last accessed on March 17, 2014.

advanced sighting systems became available in the later decades of the 20th century. Precision ground attack with rudimentary sighting systems was also made possible with pilot skill overcoming the limitations of the existing technology in sighting and guidance systems. A shining example of a pilot incorporated precision ground attack is the IAF's No. 28 Squadron's, MiG-21FL's 57 mm unguided rocket precision attack on the governor's residence in Dacca during

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the 1971 Indo-Pak War; a shining example illustrating the truism that weapons are just weapons and they can achieve tactical or strategic results based on the skill of their timely application in time and space. Today, through mainly evolutionary, though at times, revolutionary, technology development and incorporation into modern weapon systems, precision attack capability has become more commonly available: this has been possible due to the development and widespread and ready availability of specialist weapons such as Laser Guided Bombs (LGBs) and Precision Guided Munitions (PGMs) like the Joint Direct Attack Munition (JDAMs) that use technical means of guidance like the Global Positioning System (GPS) making precision attack much easier to replicate on a large scale and apply where required. Operator training levels, while still important, are less so than was the case earlier and skills of assimilating new technology and techniques may today be more important than mental Dead Reckoning (DR) computing of weapon aim point lay-offs in the prevailing conditions to achieve the desired precision results.

• **Graded Response Capability:** Graded response capability derives from the ease of applying carefully graded force through carefully calibrated application of the desired or "just right" amount of force. In the air power context, this graded application of force can be achieved through the choice of the number of aircraft in an attacking force and their weapons load up apart from the type of weapons selected (say a scale varying

Weapons are just weapons and are not tactical or strategic but the effects of their application are. The words tactical and strategic apply to effects and not to the weapons themselves. from two aircraft each carrying one 250 kg LGBs as against six aircraft each carrying six 1,000 kg conventional iron bombs) and the relative ease of scaling up or down the applied force through the choice of throwweight and the choice of specific target systems to be attacked. Graded response capability, thus, depends upon the target selected for attack as well as the amount, calibre and precision of force applied against the selected target, the latter determining the amount of damage desired to be caused to the target of

choice.

٠ **Inherent Strategic Effect:** The inherent strategic effect of air power, in contrast to the limited strategic effect of the surface forces, is evident from the fact that for an army to have strategic effect, it usually needs to defeat the opposing army in detail in the field and then threaten the enemy's heartland, while a naval force would require to totally interdict the enemy's lines of maritime communication or totally blockade his sea ports if the enemy is dependent upon maritime trade, while, in the case of air power, the inherent strategic effect of even tactical assets is most clearly brought out once again by the 57mm rocket attack by the IAF's MiG-21FLs on the governor's house in Dacca in December 1971. The clearly 'tactical' MiG-21 aircraft used, in conventional thinking terms, the "purely and obviously" tactical weapon, the 57mm hollow charge anti-armour rocket, to achieve an undisputedly strategic effect, the unconditional surrender of over 90,000 combat-worthy and 'undefeated in the field' enemy combatants, through timely and precise application of carefully graded firepower. This brings out quite clearly that weapons are just weapons and are not tactical or strategic but the effects of their application are. The words tactical and strategic apply to effects and not to the weapons themselves.

These unique characteristics of air power are unchallenged in the history of warfare and from an examination of these it flows that a nation that correctly utilises air power has the potential to achieve a decisive advantage for military or political purposes. Note the Indian success in dislodging well dug in Pakistani troops during the 1999 Kargil War that defied the hitherto held conventional wisdom that in the mountains an advantage of 9 to 1 in favour of the attacker with well acclimatised troops would be required (though still with horrendous losses to the side aiming to dislodge well dug in opponents) to dislodge well dug in enemy troops in the mountains. In the Kargil War, the Indian Army did not enjoy a 9:1 advantage nor was there time to induct well acclimatised troops while recapturing the posts in the Kargil, Dras and Batalik hills from the

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enemy. While the Indian Army's losses were heavy, they were much lighter than they would have been if the IAF had not sustained a day and night aerial bombardment campaign against enemy troop positions and their logistics infrastructure. The US operations in the two Gulf Wars since 1991 in contrast to the innovative approach shown by the IAF in Kargil, brought out the unstoppable technology dominance that air power can bring to a modern battlefield.

This is brought out most starkly by two watershed military operations in the past three decades. The first was the US led coalition forces' war against Iraq subsequent to Iraq's invasion of Kuwait, the Gulf War of 1991. In this war, a dedicated and sustained coalition forces air campaign against Iraq that commenced on January 17, 1991, called "Desert Storm", over 42 days, resulted in almost total absence of requirement for a land war. The land allied offensive, "Operation Desert Sabre" was able to wrap up its activities in just four days, commencing on February 24, 1991. President Bush declared a ceasefire on February 28, 1991, ending the Gulf War.⁷ The coalition land forces were able to easily enter Iraq and penetrate till the capital and beyond, facing almost no opposition due to the near total destruction of the Iraqi armed forces by the preceding air campaign. Later,

 [&]quot;Persian Gulf War", http://www.history.com/topics/persian-gulf-war. Accessed on April 3, 2014.

in Kosovo the US led coalition forces, in Operation Allied Force, between March and June 1999, were able to achieve their war objectives against Serbian forces through the use of an air campaign alone.⁸ These two examples bring out the overreaching importance of air power in modern warfare. The results and study of these relatively recent air campaigns led the Chinese political leadership to prioritise modernisation of its air force, the PLAAF over the modernisation of its naval forces and even more so over the land forces.

Disaster relief is a major area of secondary responsibility of the armed forces in general and the air force in particular. Disasters or natural calamities, such as floods, earthquakes, avalanches or fires require swift response, which is most effectively provided through military aviation. It need hardly be stated that natural calamities occur in India with uncanny regularity. Speedy transportation of rescue and recovery teams, medical aid, food supplies, relief material and evacuation of casualties are some of the activities for which military aviation is considered eminently suitable. However, it would neither be possible nor necessary to quantify the contribution of the IAF towards this national effort as such contribution cannot be provided so effectively and speedily by any other agency, nor can it be translated into monetary equivalence to be added to the Gross Domestic Product (GDP). The response to the cyclone on the Gujarat coast in June 1998, the earthquake in Gujarat on January 26, 2001, the tsunami of December 25, 2004, in the Indian Ocean, the earthquake in Jammu and Kashmir (J&K) on October 8, 2005, and more recently the devastating floods in Uttarkhand in 2013, are vivid examples of the contribution by the IAF in aid to civil authority during testing times for the nation.⁹

The economy also requires civil aviation for its efficient functioning. Civil aviation provides vital rapid logistics services for personnel and material to be moved to areas where these are required for efficient activities of a modern economy to take place on an ongoing basis. Today, it is difficult to imagine functioning without access to countrywide next day delivery

 [&]quot;Operation Allied Force", http://www.defense.gov/specials/kosovo/. Accessed on April 2, 2014.

^{9.} Information from webpage http://www.indianairforce.nic.in/show_page.php?pg_id=115. Last accessed on March 18, 2014.

courier or post services and the ability to fly people to any part of the country or the world as required on very short notice.

Thus, it is seen that for many requirements which range from military needs, through efficient civil administration in difficult times to the economic imperative, a modern nation requires to have in place strong air power (comprising both the military and civil elements of the nation's aerial ability) capability. This fact, on being recognised, saw all the major powers of a century ago investing heavily in the development of a viable domestic aviation infrastructure and air power capability. India, as we have seen, entered the aviation field just a step or two behind the pioneering aviation nations close to a century ago. As we enter the new millennium, the old world order is changing, with new players emerging to replace the earlier great powers. The BRIC (Brazil, Russia, India, and China)¹⁰ nations are most commonly talked about in respect of their being the expected major powers of the 21st century. It is pertinent to note that all these countries, with the exception of India, field well developed aircraft industries that are able to meet a sizeable part of their own domestic needs in addition to export of aircraft and related equipment. People reading this are no doubt familiar with famous aircraft manufacturers' names such as the Russian Aircraft Corporation (RAC) MiG, Sukhoi Corporation, Embraer, Shengyang Aircraft Corporation, Chengdu Aircraft Corporation, Aviation Industries of China (AVIC)-I and AVIC-II,¹¹ the last four being relatively new entrants in the domestically designed and built aircraft market from the PRC. While the various Russian aircraft manufacturers offer a full range of military and civil aircraft, including helicopters, the Brazilian company Embraer is progressively expanding its offerings to increase from civil use aircraft to include entry level military machines, such as the Tucano turboprop trainer and AMX light attack fighter, while the Chinese manufacturers are adding civil aircraft to their earlier military only product lines. India, in sharp contrast, has no globally competitive aircraft industry today. Over the years, the domestic Hindustan Aeronautics Limited (HAL) has produced a few moderately (though only

Jim O'Neill, Dominic Wilson, Roopa Purushothaman and Anna Stupnytska "How Solid are the BRICs?" Economic Research from the GS Institutional Portal at https://portal.gs.com. Accessed on March 18, 2014.

^{11.} KW Allen, G Krumel, JD Pollack "China's Air Force Enters the 21st Century," RAND Corporation Report from Project Air Force, 1995, pp. 135-160.

India first entered the field of aviation through the pioneering efforts of an adventurous group of young men who took up flying as a sporting activity. domestically) successful light propeller propelled trainers such as the Hindustan Trainer (HT)-2, Krishak and Hindustan Piston Trainer (HPT)-32 and one light jet basic trainer, the Hindustan Jet Trainer (HJT)-16 "Kiran" all of which were able to find a market within India alone. Of late, HAL has progressed the development of the Advanced Light Helicopter (ALH) "Dhruv" and is also developing the Light Combat Aircraft (LCA) "Tejas" and the HJT-36 Intermediate Jet Trainer (IJT) "Sitara" all of which are in different late phases of their

development and operationalisation process.

INDIA'S ENTRY INTO THE AVIATION FIELD

India first entered the field of aviation through the pioneering efforts of an adventurous group of young men who took up flying as a sporting activity. This was in the opening years of the 20th century when modern aviation was just making its first beginnings in the US and Europe. Even before the IAF itself was formed, there were Indians who were pioneers in military aviation. Three of these early Indian military aviators were Sardar H.S. Malik, Lt Indra Lal Roy, Distinguished Flying Cross (DFC) and Lt S.G. Welingkar, Military Cross (MC) who served with distinction in the Royal Flying Corps (RFC) during World War I. A military flying school was set up by the British colonial government in India at Sitapur in Uttar Pradesh in December 1913. Civil flying clubs were set up in the metropolitan cities of India at Delhi, Bombay, Calcutta and Lucknow in the late 1920s. These civil flying clubs allowed adventurous young men to learn flying as a sport. Many of them later joined the volunteer reserve and subsequently several accepted absorption into the air force once it was formed.

Military Aviation in India

With the growth of the Indian nationalist movement in the early years of the 20th century, the demand for Indianisation of the armed forces in India gained ground. A committee was formed in 1925 under the chairmanship of the Chief of General Staff, Lt Gen Sir Andrew Skeene, KCB, KCIE, CMG, to study the proposal. Regarding the air force, the committee recommended that selected, deserving Indians should be given the King's Commission to form an air arm of the Indian Army and be sent to the Royal Air Force (RAF) training college at Cranwell. The Indian Air Force Act became effective from October 8, 1932. Six young Indian cadets (Subroto Mukherjee, H.C. Sirkar, A.B. Awan, Bhupendra Singh, Amarjeet Singh and

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J.N. Tandon were sent to England in 1930 for two years' training. The first five qualified as pilots and J.N. Tandon as an equipment officer. Twentynine men were recruited from railway workshops and trained for a year as "apprentice aircraft hand". Of these 29 men, 22 qualified and were later called "hawai sepoys".¹²

On April 1, 1933 'A' Flight of No.1 Squadron of the IAF was formed at Karachi with four Westland Wapiti aircraft.

The standard of the squadron's flying and serviceability of their aircraft earned the admiration of all concerned.¹³ The squadron trained for, and took part in, operations against Frontier tribesmen along the western boundaries of British India. Calls by the Legislative Assembly for expansion of the IAF were opposed by the government, citing the high cost involved. The equipment of a single squadron cost Rs 80 lakh and its recurring expenditure was from Rs 20 to Rs 25 lakh.¹⁴ The squadron began conversion to the Hart in June 1939. The conversion was completed in a few weeks without any problems. When World War II broke out, the IAF comprised a total of 16 officers and 144 men in one squadron with three flights.¹⁵

P C Lal, My Years with the IAF (Delhi: Lancer International,1986), pp.10, 11, 12, 13; and Polly Singh, A Flight of Eagles The Westland Wapiti in the IAF Service, http://www.bharat-rakshak. com/IAF/History/Aircraft/Wapiti.html. Accessed on March 18, 2014.

^{13.} Lal, Ibid., pp. 12, 13.

^{14.} S C Gupta, *History of the Indian Air Force 1933-1945* (Combined Inter-Services Historical Section India & Pakistan, 1961). p. 4.

 [&]quot;History of IAF", http://indianairforce.nic.in/show_page.php?pg_id=98. Accessed on March 18, 2014.

The outbreak of World War II saw calls for expansion of the IAF as it was feared that the RAF, in which responsibility for India's defence was vested, may be so involved in operations in other theatres that it may be unable to spare resources for India.

Civil Aviation in India

The birth and initial years of the growth of the IAF ran in parallel with pioneering activities in the civil aviation field in India. The formation of the civil flying clubs has already been mentioned earlier. It is pertinent to note here that the first commercial flight in India was made on February 18, 1911, when a French pilot, Monsignor Piguet, flew airmails from Allahabad to Naini, covering a distance of about 10 km in as many minutes.¹⁶ The birth of Indian commercial aviation ran apace with the birth of the IAF and the first flight by an Indian on a commercial aviation task was

fulfilled with the formation of the Tata Aviation Service in 1932.¹⁷ The first flight of Indian civil aviation took off from Drigh Road airfield in Karachi on October 15, 1932, with Mr JRD Tata at the controls of a Puss Moth biplane that he flew solo to Ahmedabad and then on to Bombay¹⁸. Tata Aviation Service later became Tata Airlines and then Air-India and even later spread its wings abroad as Air-India International.

The outbreak of World War II saw calls for expansion of the IAF as it was feared that the RAF, in which responsibility for India's defence was vested, may be so involved in operations in other theatres that it may be unable to spare resources for India. Newly raised Coast Defence Flights (CDF) carried out long surveillance missions over coastal waters and, at times, escorted ship convoys through maritime trade lanes. Japan's entry into the war in 1941 accelerated calls for expansion of the IAF. The 1940 Plan 'A' for an effective air component of forces for the defence of India put the air requirements of India at 21 squadrons and 5 CDFs consisting of a total of 282 aircraft. The updated 1941 plan, taking into consideration deteriorating

Murali N. Krishnaswamy, "One Hundred Years of Flying High", http://www.thehindu.com/ features/kids/one-hundred-years-of-flying-high/article2584818.ece. Accessed on March 20, 2014.

^{17. &}quot;JRD Tata : Sprit of the Skies", http://www.tata.in/article/inside/Pk4mYoO!\$\$\$!iUY=/ TLYVr3YPkMU=. Accessed on March 21, 2014.

^{18.} Ibid.

relations with Japan, raised the requirements to 6 CDFs (57 aircraft) 21 squadrons (325 aircraft) and 2 CATUs (12 aircraft each). Against these, India had 5 CDFs of the IAF Volunteer Reserve (IAFVR), 2 RAF squadrons and 1 IAF squadron. By the time World War II ended, the IAF had expanded to 9 squadrons flying Hurricane, Spitfire, Vengeance and Dakota aircraft and had been blooded in battle in northeast India and in Burma.¹⁹

Growth of Support Infrastructure

This rapid growth of aviation in the country in the first half of the 20th century in both the military and civil fields required the putting in place of a suitable maintenance infrastructure; as all readers would be aware, the operation of any mechanical devices requires ready access to suitable repair and overhaul facilities as well as supply of spare parts, etc. As all the aircraft of the time were imported from Europe and there was no industrial base of any significance left in India, it was not considered feasible to set up manufacturing plants in India at the time. The IAF, due to its nature as a military force, with vital national defence tasks, required to have engineering skills adequate to keep its aircraft airworthy enough to execute their tasks. Hence, in the initial years, the hawai sepoys, were inducted and trained for maintenance tasks. As India was then a British colony, import of aircraft from the UK was considered acceptable, especially as independence from British rule was at the time still far from expectations in the then near future. In the initial years, the hawai sepoys, the 'ancestors' of today's airmen and officers of the Maintenance Branch, worked under the supervision and guidance of British airmen. At the end of March 1939, "for the first time, Indian SNCOs took charge of their trades and successfully discharged their duties. As the years passed, the IAF upgraded to better equipment than the Westland Wapiti with which the IAF was initially equipped, such as the Lysander aircraft followed by the Vultee Vengence and Hurricane and later the Spitfire. Indian airmen easily adapted to maintaining these newer aircraft and indeed such was their confidence that not only were they able to maintain these newer machines satisfactorily but they also applied their ingenuity towards modifications to the original designs aimed at improved reliability and usability such as the modification

^{19. &}quot;History of IAF", http://www.indianairforce.nic.in/. Accessed on March 22, 2014.

of the tail skid unit of the Lysander aircraft, modifications that were accepted by the Original Equipment Manufacturer (OEM) as feasible and valuable and were later implemented on the global fleet of these aircraft, leading to appreciable improvement on the entire global fleet of Lysander aircraft".²⁰

INDIAN AVIATION SCENARIO TODAY

India today fields the world's fourth largest air force after the US, Russia and People's Republic of China.²¹ India's civil aviation sector, after years of tight regulation, started to boom since the mid to late 1990s and despite some infrastructure and regulatory problems, remains poised for further growth in the coming years. In sharp contrast to other countries that host such large military and civil aviation sectors, India today remains primarily import dependent to meet its needs of aircraft and associated support equipment. This stands in stark contrast to the situation prevailing in the US, Russia, China and even in smaller countries such as France and Brazil where almost all design and manufacture of the bulk of their aircraft and related support equipment needs are met by domestic companies. This situation in other aviation countries stands in sharp contrast with India's primarily import based aviation sector, despite a robust civil engineering industry and an economy currently growing at the second highest rate in the world after the PRC, and leads to curiosity about the reasons for this import dependence, its long-term feasibility and the prospects and implications for the future of India as an aerospace power. Before proceeding further, it is relevant to understand the importance of a nation's air power for not just military security but also for the efficient functioning of the administration and economy.

Moreover, the present being but an edifice built upon the foundation of the past, in order to address the current and future state of the Indian aerospace industry, it is relevant to trace the historical path that has brought it to this stage and then to project the future prospects and to analyse possible methods and models that may be applicable in ensuring healthy growth of this industry in the future.

^{20.} Gupta, n.14, pp 4-10.

^{21.} Information from website http://www.scramble.nl/. Accessed on March 2, 2014.

NASCENT AIRCRAFT INDUSTRY WITHIN THE IAF AND IN THE CIVIL ARENA

The IAF efforts were only aimed at satisfactory maintenance of the equipment in IAF service with no pretensions towards setting up a nation-wide aircraft industry, though personnel who had served in the IAF formed a pool of trained aircraft savvy technicians who could be deployed in aircraft building projects post their IAF service if the need were to arise.

The genesis of an aerospace industry lies in the existence of domestic military and/or civil aircraft operators who require the products and The genesis of an aerospace industry lies in the existence of domestic military and/or civil aircraft operators who require the products and support of, and, in turn, provide support to, a domestic aerospace industry.

support of, and, in turn, provide support to, a domestic aerospace industry. Hence, the genesis of the Indian aerospace industry lies in the build-up of aviation activities within India in both the military and civil fields.

The concept, thought and initial action of establishing an aircraft industry in India came from a visionary individual, who saw the requirement eventually for indigenous aircraft design and building to support the rapidly growing military and civil aviation sector operators in India, and not the government. Seth Walchand Hirachand laid the foundations of the Indian aircraft industry at Bangalore in 1940. It all began with a visit by Seth Hirachand to the US for discussions with the Chrysler Corporation for setting up a car factory in India. On his flight back to India, he met and interacted with Mr Pawley who was then the director of the Harlow Aircraft Company. Seth Walchand was so enthused about aircraft manufacturing in India that during the flight itself he held detailed discussions with Mr Pawley and finalised a draft plan to set up an aircraft factory in India. Mr Pawley at the time was on his way to China to oversee the aircraft factories set up there for the Chinese Nationalist government in association with American aircraft manufacturer Curtis Wright. Seth Walchand was so keen on the project, and impatient to make a quick start, that he sent a detailed cable to the commander-in-chief India from the stopover at Manila itself. After his fifth cable, the commerce member of the government conveyed

Indian aviation owes an incalculable amount to the efforts of a single extraordinary man, Mr JRD Tata. Mr JRD Tata was the first Indian to get a pilot's licence in India in 1929. that he would discuss the matter on his next visit to Bombay. This was in October 1939. After the full implications of the war in Europe became clear, the British government in London issued instructions that India should make its own arrangements for its defence, especially in the air. Around this time, Japan had opened the war front in the east. In this situation, the Viceroy of India Lord Linlithgow, finally took interest in Seth Walchand's project proposal and guaranteed support for him to set up an aircraft

factory in India.²² Thus, Seth Walchand Hirachand, a visionary private sector industrialist established India's first aircraft factory, Hindustan Aircraft Ltd, at Bangalore on December 23, 1940, with some support from the Mysore state government and work assurance from the Government of British India²³. This formed the true genesis of the aircraft industry in India. Thus, this industry in India started in the private sector. Seth Walchand Hirachand was not the only noteworthy person who contributed to the growth of aviation, leading to the very need for a domestic aerospace industry. Another such notable individual was Mr JRD Tata.

Indian aviation owes an incalculable amount to the efforts of a single extraordinary man, Mr JRD Tata. Mr JRD Tata was the first Indian to get a pilot's licence in India in 1929. He later founded Tata Airlines, and remained closely involved with aviation in India as well as globally. In India, he made large contributions to the establishment of the required aviation infrastructure. Globally, he played a major role in the functioning of the International Air Transport Association (IATA) serving also as its chairman in 1958-59.

He did not venture into aircraft building, etc apart from setting up pure R&D organisations such as the Tata Institute of Fundamental Research (TIFR), and he did not foray into the aircraft industry *per se*, a decision that may have owed a lot to the political decision to reserve aircraft building for the government run public sector and deny the private sector any role

^{22.} Deshpande, n.2, pp 60-65.

^{23.} Ibid., p. 16.

in it in independent India till very recently. The Indian government's policies became clear even before independence when the Indian National Congress, in its 1946 session, adopted an industrial policy that reserved major and strategic industries, including aircraft building, as the exclusive preserve of the state.

HAL FORMATION AND THE INITIAL YEARS TILL INDEPENDENCE

HAL was established as Hindustan Aircraft in Bangalore in 1940 by Seth Walchand Hirachand HAL was established as Hindustan Aircraft in Bangalore in 1940 by Seth Walchand Hirachand with financial support from the Mysore state and assurance of work from the Indian government.

with financial support from the Mysore state and assurance of work from the Indian government. Hindustan Aircraft Limited was born on December 23, 1940, and began its historic journey as the flagship of the Indian aviation industry. HAL was registered as a private company with an authorised capital of Rs 4 crore. Production lines were established in collaboration with the Inter-Continental Aircraft Company of the USA for the manufacture of the Harlow trainer, Curtiss Hawk fighter and Vultee attack bomber. The initiative was actively encouraged by the Kingdom of Mysore, especially by its Diwan, Sir Mirza Ismail. The British government bought a one-third stake in the company by April 1941, as it believed this to be a strategic imperative. Later, in April 1942, it bought out the stakes of Walchand Hirachand himself and other promoters so that it could act freely. The decision by the United Kingdom was primarily motivated to boost British military hardware supplies in Asia to counter the increasing threat posed by Imperial Japan during World War II. However, the Mysore Kingdom refused to sell its stake in the company but yielded the management control over to the British government. Thus, within two years of its establishment, HAL was nationalised. There has, thus, been a government monopoly on aircraft manufacturing in India from almost the very beginning of this industry in this country. It bears pondering upon whether the nationalisation of this first private attempt at setting up aircraft manufacturing in India played a part in deterring other major industrial concerns such as the Birlas, Mahindras, Tatas and the like, from foraying into this area.

The first flight of a Harlow trainer was achieved by the newly established HAL in the record time of one year. This was followed a year later by India's first indigenous design and development effort, a ten-seat glider, the G-1, designed by Dr V M Ghatage, the first chief designer of HAL. The fact that this fledgling aircraft company featured a full-fledged design and development department is potent evidence of the progressive thinking of the forward looking visionary, Seth Walchand Hirachand, who conceived the idea of setting up this organisation with a view to ensuring India's rightful place amongst the club of aviation nations. However, to support the World War II allied war effort in the Asian theatre, aircraft manufacturing programmes at HAL were abandoned in favour of repair and overhaul and the company became the principle overhaul base for the Southeast Asia Command of the allied forces.

In 1943, the Bangalore factory was handed over to the United States Army Air Force while still using HAL management. The factory expanded rapidly and became the centre for major overhaul and repair of American aircraft and was known as the 84th Air Depot. The first aircraft to be overhauled at HAL was a PBY Catalina followed by every type of aircraft operated by the allied air forces in India and Burma. When it was returned to Indian control two years later, the factory had become one of the largest overhaul and repair organisations in the East. Repair and overhaul of many aircraft used in support of the allied war operations, such as the Fortress, Liberator and Mitchell bombers, Dakota and Commando transport aircraft and Catalina amphibians was undertaken. After the war, HAL undertook reconditioning and conversion of war surpluses such as the Tiger Moth trainers, Tempest fighters, Liberator bombers and Dakotas for the IAF and for Indian civil operators. In the interim, HAL also entered into a licence agreement to manufacture the Percival Prentice trainer aircraft for use by the IAF.

After India gained independence in 1947, the management of the company was passed on by the British government to the Government of India. Though HAL had not been actively involved in developing newer models of fighters, and other classes of aircraft, *ab initio*, it played a crucial role in the modernisation of the Indian Air Force over the years.

After India gained independence, HAL remained nationalised and the new Indian government, while formulating and articulating its industrial policy, reserved aircraft manufacturing for the public (government owned and operated) sector of the economy, thus, establishing a monopoly for HAL in the field of aircraft building in India. Thus, the big Indian industrial houses such as the Tatas, Birlas, etc were forced to stay away from this field even if they had wanted to enter this industry and HAL remained the sole operator in the field of aircraft building in independent India. This monopoly led to all projects concerned with aircraft being given to HAL and this one company, thus, prospered with its order books overflowing with orders for the IAF and other players in the aviation field in India. After the licensed production of the Harlow trainer and Vultee Vengence dive bombers in the early to mid-1940s, HAL designed the HT-2 India's first powered aircraft designed and built within the country. The HT-2 saw extensive service with the IAF and a few were exported also, though with limited success.

Later on, HAL built the Vampire and Gnat fighters under licence, while at the same time, designing India's first indigenous jet trainer, the HJT-16, and India's first indigenous jet fighter, the HF-24 Marut, and went on to build the HS-748 transport aircraft and MiG-21 supersonic fighter under licence. Still later, HAL built India's first helicopters, the Cheetah and Chetak, under licence, designed and built indigenous light aircraft such as the Pushpak, Krishak, Basant, HPT-32 and later the LCA Tejas and ALH Dhruv. All through this period, licensed manufacture of cutting edge aircraft such as the Jaguar, MiG-21Bison and Su-30MKI continued. With these major projects, HAL emerged as one of the largest aviation companies in Asia, covering a large swath of products that included sub-systems and avionics to complete aircraft and even parts for spacecraft [built for the Indian Space Research Organisation (ISRO)]. Today, HAL has become a major player in the field of aircraft design and manufacture with its expertise recognised globally. It supplies parts to the aviation majors in Europe and the US apart from building a full range from sub-assemblies to complete aircraft for domestic customers. Its product range covers the full spectrum of aviation products. This journey has not been an easy one for HAL. HAL has required to absorb new technologies rapidly and strive to retain its aircraft design and development expertise despite a near total lack of funding to pursue purely R&D activities. Its fortunes have mainly depended upon the equipment requirements of the IAF, to meet which HAL has required

to bid at times against established international giants in the aviation field such as Boeing, British Aerospace, et al. HAL has also faced considerable, and at times quite unfair, criticism from the IAF and in the media for its inability to deliver equipment comparable to that offered by the likes of Boeing despite its sanctioned funding for such projects being a fraction of what international majors in the aviation field spend annually on just technology development, let alone aircraft design and development. For instance, the LCA Tejas programme is reported to have cost a total of US\$ 2 billion while the global norm for such a project is generally over ten times as much. Of late, since 1991, the government has modified its industrial policy to allow the private sector to operate in the field of aircraft building and in defence related sectors. This change has seen several new operators enter this field and the increased focus of large Indian corporates should lead to greater competitiveness in the industry.

CONCLUSION

Aviation has made major advances since its introduction in the early 20th century. Today, a country's capability in aviation is a major factor in the determination of its military might. Aviation also plays a crucial role in making a country's economy efficient. Hence, aviation has become a major determinant of a country's overall power. India entered the aviation field in its infancy. Since the formation of the IAF and commercial aviation in India these services have expanded greatly. India's first aircraft manufacturing facility, HAL, was set up in the private sector in Bangalore in December 1940. Due to the exigencies of war, HAL was soon nationalised and converted to a repair and overhauling centre for allied aircraft. In 1947, control of HAL was handed over to the government of independent India. Since then, HAL has remained nationalised. Though Indian socialist industrial policies could have played a part in keeping the private sector out of aircraft manufacturing, HAL, over the years, has made several important contributions.