FUTURE OF AVIATION TECHNOLOGY AND BUSINESS IN INDIA

C.G. Krishnadas Nair*

Introduction

Civil Air Transport was ushered in on October 15th 1932 by JRD Tata flying the Puss Moth from Karachi to Bombay. Air India was incorporated in 1946. Indian Airforce was established in October 1932. A visionary Industrialist Sri. Walchand Hirachand, established Hindustan Aircraft Limited (HAL) in Bangalore in 1940. Dr. V.M. Ghatge joined as Chief Designer and developed a glider in 1941 and an all metal fully aerobatic piston trainer HT-2 in 1951. It was HALs Chief Designer, Dr. V.M. Ghatge who established the first Department of Aeronautical Engineering in India at the Indian Institute of Science (IISc), Bangalore in 1942. Subsequently, Dr. Ghatge and his team built-up considerable Design Engineering base in HAL and designed and developed a variety of aircraft indigenously.

While HALs design and development of military aircraft grew rapidly, a number of R&D Labs under Defence Research and Development Organisation (DRDO) (1958) and National Aerospace Laboratories (NAL) (1959) under CSIR were established for fundamental and applied research in Aeronautics, contributing to the growth of Science and Technology of Aeronautics.

With this Industrial R&D base and the unprecedented growth of civil and military aviation in India and the recent Offset Policies in our Aircraft and Defense purchases, there is considerable opportunities for the Indian aircraft industry to grow through partnerships: industry-industry partnership, industry-R&D partnership and through international collaborations.

Growth of Civil Aviation

ICAO predicted about a decade ago, that Asia and in particular India and China will dominate in the growth of Civil Aviation in the future. (Fig.1). This prediction has come true and Civil Aviation has been growing by leaps & bounds in India. The aircraft movements in the past five years have shown an increase at the rate of about 17% reaching 9,79,000 landing/takeoff per year in 2006-07 from Indian Airports. The passenger traffic has grown by 22%, cargo by about 10% in last two years. The trends and forecast of passenger traffic and cargo traffic are illustrated in Fig.2 and Fig.3. Even at a much lower (than the current) rate of growth, the passenger traffic is estimated to grow from the present 90 million/year to 313 million/year by 2015 and 605 million/year by 2020. The growth in passenger traffic and cargo and the open sky policy have led to the growth of several new airlines both in public and private sector. The population of transport aircraft (50 seater and above) has almost tripled from 1995 to 2006 and is estimated to more than double by 2015 and perhaps tripled. Some forecasts indicate this to grow to about 2000 by 2020. (Table-1). The Airline Industry of India is expected to spend more than Rs.1,3,20,000/- million by 2015 for purchase of passenger aircraft. There is also similar growth potential for small Aircraft, Corporate Jets and Helicopters.

Growth of Military Requirements

Indian armed forces and para military forces have a fleet of trainer, fighter and transport aircraft and helicopters. These consist of HAL-designed and built as well as licence produced aircraft. There is considerable need for replacing some of the ageing fleet as well as up-gradation and development / induction of advanced technology military aircraft including ALH, LCA, Future Fighter, MCA, Unmanned Aircraft and Helicopters, Air borne early systems, and various other Military Aerospace equipments. In our quest for greater self reliance there is growing requirements in the design and manufacture of aerospace instruments, equipments and systems, and associated materials and technologies. UAVs have a crucial role to play in future warfare and there is need to develop a variety both fixed wing and rotary wing UAVs. There is a considerable requirement for engineers to design and develop aircraft and weapon - ground handling equipments.

Offset Clause in Future Procurement

A mandatory offset clause has been introduced for all future aircraft and defence procurement varying from...
30-50% by value. The objective of this is to expand the domestic aerospace and defence industries base through foreign investment and technology transfers and also to enhance export. Offset provisions will apply to ‘Buy’ (out right purchase) and ‘Buy & Make’ with transfer of technology. The Offset obligation is to be discharged directly or by combination of direct purchase (export) of materials, components, structures, design, software solutions and services. Investment in Indian companies either as joint venture partner through financial partnership or providing technology at mutually agreed value will qualify for offset credit. Overseas bidders have to indicate (in all future response to tenders) their offset partners in India, likely products / services and value proposed to be procured from them. It is understood that the present Boeing commitment is about US $ 2 billion and Airbus offset obligation is about 0.5 billion and likely to go up to 1 billion. With additional purchase of aircraft in the next decade this is expected to be tripled. Global tenders for Multirole Combat Aircraft just released is valued at 10 billion US$ for 126 aircraft. The offset clause is 50% valued at 5 billion US $. Big Private Sector Industries are showing interest for getting into aerospace business. Major overseas suppliers of aircraft and defence equipment are identifying Indian companies as offset partners.

### Indian Aircraft Industry Structure

Indian Aircraft Industry consists of Hindustan Aeronautics Ltd., the maintenance and service depot of armed forces, airlines and their MROs and a large number small, medium enterprises in the private sector. It is complemented by some of the DPSUs who are involved in the development and manufacture of aerospace materials, equipment, and systems. With the globalization and the new opportunities provided by the unprecedented growth of Aviation in India and the offset clause in aircraft and defense purchases, a number of large Private Sector and Public Sector Industries are entering the field. On the R&D front, HALs pioneering efforts in the design and development of aircraft aerospace equipments and research and development of aerospace technologies is complemented by DRDO, CSIR laboratories and research and development efforts by some defence PSUs.

HALs original objective was to design and develop military aircraft and equipments. In pursuance of this, HAL designed, developed and manufactured aircraft and aeronautical equipments along with license production creating excellent facilities and expertise. Under the design leadership of Dr.Ghatge, HAL designed and manufactured the Hindustan Trainer HT-2 which made its first flight in August 1951. Indigenous design and development of the Transonic Jet Fighter HF-24 (Marut) was launched with Dr. Tank leading the Indian design team in 1956 and the prototype flew in 1961. This aircraft soon entered into active service with Indian Air Force as an effective interceptor and ground attack fighter. To meet the need for training in Jet Aircrafts, Kiran a basic Jet Trainer Aircraft, was also designed and developed and flown in 1964 under the able guidance of Dr.Ghatge and Mr. Raj Mahindra. HAL entered from Military to Civil Transport Aircraft with the setting up of facilities at Kanpur for the manufacture of HS-748. With facilities established at Nasik and Koraput for the MiG Aircraft and its engine, and Helicopter and Aero Engine Division in Bangalore as well as Avionics and Accessories divisions at Hyderabad and Lucknow, HAL continued to grow in size and stature.

Table-2 gives a list of HAL made Aircraft and Helicopters. It clearly indicates that after a successful start R&D was overtaken by license production.

HAL did not succeed in getting approvals for its proposal for new R&D projects for advanced fighters, trainers and transport aircraft. There was no follow - on project after the first effort in supersonic attack aircraft the HF-24 although HAL proposed an HF 25. An advanced Jet trainer aircraft could have been successfully developed by HAL after the Kiran MKII; but it was denied to HAL. Vested interests, and the lack of long term planning, made sure that the requirements are met by import and at best by licensed production of aircraft. A long period followed where HAL expanded its production facilities for licensed manufacture of foreign military aircraft. While this gave some inputs in manufacturing technology, the design and development suffered, and the skills eroded steadily.
HAL R&D put up a number of proposals from time to time to design and develop light transport and 50 / 60 seater passenger aircraft in early 70s but were turned down by the GOI, as HAL was under the Ministry of Defence and HALs mandate did not include the design and development of civil transport aircraft.

HAL redefined its mission and objective in 1997 to diversify to civil aircraft and related areas of HALs core competence and work as a commercial organization instead of a cost+ profit company, in its bid to become more productive, efficient and globally competitive. HAL drew up a long term strategic plan covering 1997 to 2007 with emphasis on R&D, diversification and growth. A corporate R&D fund was created, making by a board resolutions making it mandatory that 20% of the profit or 2% of sales which ever is higher should be put into the R&D reserve each year. The Design department were redefined as Research & Development Organizations and co-located with concerned manufacturing divisions to establish greater synergy. (Fig.4). It also became proactive to customer requirements rather than re-active and launched a number of R&D programmes. Instead of grieving on lost opportunities, it decided to play a dominant role by synergizing with ISRO, DRDO, National Labs and Private Sector. The LCA project had been much delayed, and was further adversely affected by the American embargo. HAL started playing a more aggressive role in accelerating the LCA. R&D was strengthened by induction and training of additional design engineers and technicians as well as by making substantial investments in CAD work stations, LAN and in computer aided software tools, to improve quality an productivity of design. These steps, taken by HAL, were aimed at providing a major thrust and accelerate the on going projects such as LCA and ALH, and enable undertaking of new projects with much shorter lead time.

LCA made its maiden flight on 4th January 2001 and subsequently entered limited series production. The world class high-tech advanced Light Helicopter was successfully designed and developed and production commenced in 2001. HAL initiated the New Jet Trainer project in July 99 and completed in a record time of 44 months, flying the first prototype on 7th March 2003. Fig.5 illustrates the renaissance of aircraft design and development and successful new aircraft projects. A number of aircraft design projects including Aircraft / Helicopter upgrades have been successfully completed. There has been considerable development in the associated enabling technologies such as advanced materials, structures, avionics, equipments and systems. New projects such as the Light Transport Aircraft and large aircraft (50-60 seater and 100/120 seater) are planned to be taken up. An offset policy has been incorporated in Civil Aircraft purchases and Defence purchases.

**Table-2 : Aircraft Produced by HAL**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Year (Period)</th>
<th>Aircraft Type</th>
<th>Indigenous Design</th>
<th>Licensed Production</th>
</tr>
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<tr>
<td>1</td>
<td>1952</td>
<td>HT-2 Trainer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1959</td>
<td>Pushpak Light Aircraft</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1959</td>
<td>GNAT Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1960</td>
<td>Krishak Light Aircraft</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1964</td>
<td>Kiran MK I Trainer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1964</td>
<td>Marut Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1970</td>
<td>Chetak Helicopter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1970</td>
<td>Cheetah Helicopter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1972</td>
<td>MiG 21 M Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1973</td>
<td>Basant Light Aircraft</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1975</td>
<td>HS 748 Transport Aircraft</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1976</td>
<td>Kiran MK II Trainer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1977</td>
<td>HPT-32 Trainer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1978</td>
<td>Ajeet Fighter</td>
<td>✓</td>
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</tr>
<tr>
<td>15</td>
<td>1982</td>
<td>Jaguar Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1985</td>
<td>MiG 27 M Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>1986</td>
<td>DO 228 Transport Aircraft</td>
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<td></td>
</tr>
<tr>
<td>18</td>
<td>1997</td>
<td>ALH Helicopter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>1999</td>
<td>Lancer Helicopter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>2001</td>
<td>LCA Fighter</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>2005</td>
<td>Su 30 Fighter</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

**R&D for Enabling Technologies**

R&D is the engine for growth of industries. While we had some success in the development of basic technolo-
gies, materials equipments and systems through the development of LCA, IJT and ALH we need to continue our efforts in the development of design enabling science and technologies, such as aerodynamics and configuration, materials and manufacturing, structural design and analysis, equipment, systems and controls and IT tools and technologies. We need to focus on sustained research & analysis in all these areas to enhance our knowledge and technology to meet the demands of future design and development of more sophisticated and advanced aircraft.

Future designs will be driven by considerations other than the conventional performance and stability. Factors such as stealth, noise and emission regulations are assuming greater importance. Stealth technologies essentially involve reducing the radar cross section and the infra red signature. Research in these areas is highly confidential and not much information is available in the public domain. Therefore there is a need for indigenous research effort to develop materials and techniques for analysis. Noise and emissions are other areas where regulations are likely to be stringent in the future, especially related to civil aviation. In these areas, research tasks need to be undertaken for better understanding of the issues involved.

Development of smart structure technology is to be taken up and perfected. In such structures piezo electric and miniaturized microprocessors are embedded in the structure and signals from these are monitored to assess the stress levels, which can be further processed to give fatigue state, impending damage due to crack etc. Techniques are also to be developed for dynamic control of structure using signals from embedded elements and shape-memory alloys.

More development work to generate data on the effect of humidity, temperature and other environmental conditions on the composite material is required to be undertaken. Use of 3D solid modeling structural design is still in a state of infancy and only a modest beginning has been made in virtual reality concepts. R & D thrust in these areas would be required for developing expertise in the design of optimum structures at minimum cost and time.

The Fly-by-Wire Control System has gained maturity that it is being introduced in civil transport aircraft with confidence. In India, expertise related to system design, system test rig design and testing of such high technology Hardware and Software has been acquired. In order to minimise possible risk associated with the electromagnetic interference effects, there is a trend towards fly by light technology that use optical fibres for communication of signals. There is a strong need to develop this technology for airborne applications. The scope of fly-by-wire system is expanding to include propulsion control, fire control and thrust vectoring nozzles.

There has been considerable progress in the capabilities related to Avionics and accessories design, development, certification and integration. Issues related to flight certification and actual flight experience are appreciated through the LCA, ALH and IJT programmes and there is need to continue R&D in this field for building up design & testing expertise for future programmes.

A number of high strength aluminium and magnesium alloys, alloy special steels including maraging steels, titanium alloys and nickel based super alloys have been indigenously developed in various forms. Process technologies for precision forgings, ring rolling, precision castings, advanced technology coatings, cold and hot forming of sheet metals, welding and brazing etc., have been developed. Various types of adhesives and sealing compounds have also been developed with indigenous R & D. Rapid strides have been made in the area of honeycomb sandwich structures, fibre reinforced composites, which include glass, carbon, and kevlar fibre composites and hybrids and the latest of technologies such as co-curing and co-bonding.

However, there are several critical areas requiring dedicated research to meet the needs of the future aircraft. Vacuum investment casting and Hipping (Hot Isostatic Pressing) technology for turbine and compressor rotors and stators, single crystal turbine blade casting, isothermal forgings, diffusion bonding & super plastic forming of sheets, development of high strength glass fibres, carbon fibres and kevlar fibres and prepregs and metal and ceramic composites, titanium aluminides, are just a few examples. R & D in various types of sensor materials, stealth materials and coatings, smart materials and structures are important areas, which need to be pursued. (Fig.6).

Computer Aided Software Tools (CAST) for design and analysis along with concurrent engineering greatly enhanced productivity of design from concepts to completing the development. Application of CAST and concurrent engineering in the LCA and IJT project have built up Design efficiency to meet global standard and India’s expertise in this field can be leveraged successfully in the
coming years for taking up future design & development projects in India and to participate in the international projects.

The future will need to cater to the increasing demands of the designers for faster visualization and evaluation of their concepts without physically building mockups, and, models for testing. A case in point is the advent of Virtual Reality (VR) which facilitates visualization, manipulation and interaction with computers and complex data. VR will help the designers to push their ideas faster across management and the customer. We need to equip our design centers with this tool & technologies and build up expertise so that our designers will use this breakthrough technology to its full potential in the future projects.

**Design and Development of Future Aircraft**

With the boom in civil aviation and the large scale induction of transport aircraft of various capacities and the opportunities provided through the offset clause in our aircraft purchases, there is great potential for Indian industries and R&D organizations to take up design and development of transport aircraft.

The country’s first effort in design and development of a small Light Transport Aircraft sphere headed by National Aerospace Laboratories (NAL) is not yet certified even three years after its maiden flight. Considerable structural & design optimization and weight reduction is required to be done and a few more prototypes to be made and flight tested leading into certification. Commercial viability for manufacturing is another matter.

However, the market for 50 seater and above is growing very rapidly. It is desirable to undertake design and development of 50-60 seater, 100-120 seater and 180-200 seater aircraft very quickly. There is considerable scope for successful programme in this area. Realizing this, HAL has already taken initiative for design and development of a Multi Role Transport Aircraft with national and international co-operation. The aircraft is planned to be designed with a common platform and with passenger variant, military troop and transport variant and cargo variant. In the passenger variant, it will have a seating in the range of 100-120. In the military transport variant it will have a range of 2500km with 18 ton load and 3600 km with 12 ton payload and 6000 km with 4.5 ton payload. Our goal should be to take up 50-60 seater, 100-120 seater, 180-200 seater passenger aircraft by an ‘Airbus type’ consortium. In the design and development projects, we should not wait for one project to be completed to take up the next one.

In the field of military aircraft, we must take up the development of an MCA and the next generation fighter aircraft immediately. LCA is already in series production in HAL and LCA navy and other derivatives including LCA trainer are under development. The design expertise built up through the LCA project should be utilized for meeting the country’s future military aircraft needs. Efforts to import such requirements must be checked, as it will be repeating our old mistake of not taking up followon project after the successful development of Maruth the **HF-24 Fighters**.

Having successfully developed the high technology world class Advanced Light Helicopter, HAL must take up the design and development of the Light Observation Helicopter and Indian Multi role 10-15 ton Helicopter in collaboration with risk sharing partners from Indian Private Industries and Overseas Helicopter Design and Manufacturing industries. The R&D competence built up in the area of Rotary wing Aircraft will erode with time, if we do not take up such projects immediately and also will result in import of such helicopter to meet our needs.

All the projects must go in parallel with a short phase lag to facilitate continuous and optimum utilization of all specialized design disciplines and to get from design to the market with good speed and in good time, as indicated in Fig.7.

**Growth through Industry R&D Partnership**

HAL has entered into partnership with ISRO, DRDO and other R&D organisation and with Academia (Fig.8) for its drive for materials and technology development and also for other design enabling technologies for future designs. Light Combat Aircraft (Fig.9), Advanced Light Helicopter the new Jet Trainer are good examples of industry R&D partnerships, UAVs, and satellite and Launch Vehicles. HAL has already created a R&D reserve by a corporate board decision to put 2% of sales and 20% of its profit whichever is higher each year into R&D reserve, and used for developing key technologies. HAL is already looking forward for design and development collaboration and also R&D collaboration for the new projects such as Light Observation Helicopter, Unmanned Helicopter, Light Combat Helicopter, Multi Role Trans-
port Aircraft and the Indian Multi Role Helicopter. HAL, R&D, ADA, DRDO and NAL may consider a new type of partnership with private and public sector industries by giving them a stake in their new design and development projects and getting them to play a more involved role. (Fig.10).

Industry or consortium of industries should have a stake in the D&D, by investing 20 to 30% in the project and share the production and marketing responsibility. Industry, investing in R&D / D&D along with the development agencies will be concerned and committed to speedier completion of the project and early commercial exploitation. Industry will have to position their engineers with the R&D to take up concurrent engineering and facilitate involvement right from day one of R&D and smooth technology transfer. During series, production, R&D lab personal should maintain liaison with industry until full production is established to customer satisfaction and work jointly with industries R&D for upgrades.

Industry must take on a greater responsibility for R&D and technology development by investing in R&D with Academic Institutions. Setting up of Industry Academy innovation centres, in the Institute of Higher Education will be an important step in this direction.

**Industry R&D Partnership**

- Industry share R&D expenditure and be partner in the Project
- Position industry personnel with the R&D Lab
- Concurrent Engineering and prototype build
- During series production position R&D Lab personnel with industry
- Industry to fund Academic Institutions for materials and technology development (Industry-Academic innovation centers)

**Growth through Industry Partnership**

Aerospace industries in India have high potential for growth through partnership among themselves and with overseas organizations. Growing through partnership is the mantra of this new age of globalization with ever advancing technology and need for sharing of resources capabilities and markets.

**Aerospace Public Private Industry Partnership**

- Global Market
- Cost Cutting & Enhancing Productivity
- Enhancing, Production, Diversification, Sales, Export
- Improved customer satisfaction
- New Business Areas
- Outsourcing Growth Driver
- Concentrate on Key Areas of Manufacturing, Design, Testing, Assembly, Integration
- Outsourcing Manufacturing Activities for components and assemblies, Equipments and systems
- Establish JVC, with Private Sector

HAL is the lead Public Sector Industry in aerospace in India. HAL has said goodbye to the vertical integration and developed a policy of outsourcing. Initially it started with sub-contract / outsourcing of components. In the new age of economic liberalization, and the potential for growth HAL and other PSUs have much to gain through public-private sector partnership as it is a growth driver, with better inventory and cost management. PSUs must concentrate on core manufacturing, assembly and integration. (Fig.11). For the private sector it is not economical to duplicate the vast infrastructure in the PSU. The PSUs need not invest further in machines, and facilities for components, equipments and structures. HAL realized the merit of JVs with private sector to synergize and expand business in existing and new areas and targeting growth with Indian customer and global market. Fig.12 illustrative but not comprehensive areas for forming joint ventures, Fig.13 show Aerospace PSU private sector partnership models.

SMEs play a major role in industrial production and economy. In India SMEs contribute 40% of Industrial production and 35% of export. SMEs are the second largest employment generators. In Aerospace and Defense sector SMEs contributed significantly for enhancing self reliance at a time when the large private industries were not interested in small revenues, long gestation and rigorous quality requirements. Currently with boom in aerospace and large offset big private/public industries (other than DPSUs) are getting designated as RURs for participating in the offset. SMEs must be empowered and
brought into this opportunity. Fig.14 shows illustration of synergising with SMEs for Aerospace Growth.

**Role of SIATI in Building Partnership in Aerospace**

Society of Indian Aerospace Technologies & Industries (SIATI) was founded in 1991 to develop Public Private sector partnership and industry R&D collaborations within India and with overseas organizations for enhancing self-reliance in aerospace technology and manufacturing. It has now a membership of over 300 small, medium and large scale private sector industries in addition to the major aerospace players. These industries have built-up capabilities in manufacture of materials, components, precision castings, forgings, machine parts, composites and metallic structures, rubber and plastic components, batteries, connectors, cable looms, tools, jigs, fixtures, ground handling equipments, electrical and electronic equipments and systems, as well as design, analysis and software solutions and general aviation/aerospace related services.

SIATI is an important Gateway to Indian Aerospace business and Global co-operation for tie-up in R&D technology, Joint Ventures, Collaborations, Co-productions and information-exchange. SIATI has taken delegations to National and International Airshows including Aero India, Canadian Airshow, Asian Airshow Singapore, Paris Airshows and Farnborough Airshows, UK. SIATI has organized several interactive workshops between Indian and Overseas Aerospace equipment and materials manufactures and facilitate and discuss partnership collaborations/joint ventures. It has established co-operation with similar aerospace industry associations abroad, such as Aerospace and Defence Industries Association of Europe (ASD), Belgium; German Aerospace Industries Association (BDLI), Berlin; Groupement des Industries Francaises Aeronautiques et Spatiales (GIFAS), France; Society of British Aerospace Companies (SBAC); North West Aerospace Alliance (NWAA) UK; SKYWIN Wallonia, Belgium. SIATI was a co-signatory with European Union (EU) and Ministry of Civil Aviation, GOI for the Co-operation agreement and several aerospace personnel from India have benefited through the EU India Project.

**Other Key Issues**

**National Aeronautical Policy**

Adoption of a pro-active National Aeronautics Policy with a vision to enhance aerospace design and manufacturing and maintenance capability for national prosperity by the government is essential for integrated growth on aeronautics in the country. A draft policy was prepared and put up to Government of India by the Aeronautical Society of India several years ago and this has been followed-up a number of times repeatedly by successive Presidents of Aeronautical Society. Considering the anticipated large scale purchase of aircraft by India, a proposal was put up by HAL for introducing an Offset Policy which mandates the seller of the aircraft to buy aircraft components, structures and service from India for a value equal to X% of the value of purchase of aircraft. Considerable follow-up by HAL, Aeronautical Society and SIATI and showing example of several other countries adopting such offset policy in aircraft procurement, the government has recently introduced an Offset clause for 30% of the value of purchase. This will no doubt stimulate growth of aircraft industry both in the public and private sector. The comprehensive draft policy is still to be implemented. An important part of this policy is to establish an empowered Aeronautics Commission. The aeronautics R&D, Industry and civil and military aviation are under various agencies and various ministries in the country. The purpose of the National Aeronautics Commission is to integrate and promote various aeronautical activities currently pursued by these various agencies under various ministries and facilitate national futuristic integrated policy level directions and support for a national aeronautics programme. Fig.15 illustrates this concept and networking of different organizations under the commission.

**DGCA FAA/JAA Reciprocity**

Another important issue is establishing DGCA-FAA and JAA reciprocity. While India accepts aircraft and equipments certified by FAA or JAA for use in India our products approved by DGCA are not accepted by our overseas customers. Current export from Indian industries is done under the quality surveillance of the buyer who has the approval of the FAA / JAA. In a few very limited cases Indian firms are approved for specific product by FAA / JAA. Considering the globalization of the business and new opportunities under the Offset Clause reciprocity between certifying agencies will stimulate outsourcing to India and export from Indian industries.

**Airports and Infrastructure**

Current rate of growth of civil aviation can be sustained only if infrastructure and human resources are developed. Present airports need to be upgraded to global standards and new airports have to be built. Ministry of
Civil Aviation and Airport Authority of India have already announced private public sector partnership for upgrading as well as building airports. Modernization of Delhi and Mumbai airports have also been taken up under the scheme. Development of Chennai and Kolkata airports has already been taken up. In addition 35 non-metro airports have been proposed by Airport Authority of India with modular design and modern passenger facilities. Bangalore International Airport and Hyderabad International Airport are going to be operational by first quarter of 2008. The Cochin International Airport, the first private sector airport to be successfully established with equity participation from public is an excellent model of private airports and many such airports can come in future. Apart from the airports connectivity from city to airports, by building highways and elevated / under ground railways for rapid mass transport will be required to sustain the growth of the civil aviation.

Human Resource Development

The aviation industry both the airlines and manufacturing and maintenance as well as service sectors will require substantial number of trained human resource in the coming decade. There is still no plan for meeting these requirements. It is estimated that India will require over 6000 commercial pilots in the next 10 years to meet the growing civil aviation requirements (our capacity in India is about 100 per year) In addition to Engineering graduates and technicians with specialization in the design, manufacture of aircraft, we need substantial number of aircraft maintenance engineers approved by the DGCA. In spite of a large number of private Colleges enrolling more than 2000 student each year for their Diploma courses, the percentage to pass by the examination conducted by DGCA is very poor (5-6%). There is need to strengthen the facilities and the quality of the education and training in these private institutions. There is also need to develop degree and PG programme in aircraft maintenance, airworthiness certification, air traffic control, aircraft security and safety related services, airport design, construction and operations, airlines management and allied subjects. It is the need of the time to set-up an Aerospace University or a number of such universities / institutes to meet these requirements. SIATI has taken initiatives by forming a national advisory board with very senior and eminent personalities from Academia, Research and Industry, Airlines and put up a proposal to HRD and the University Grants Commission to set-up dedicated Institutes / denovo university for this purpose.

Fig.1 Air travel maturity
Fig.2 Growth of Passenger Traffic
(The growth forecast for domestic is at the rate of 25% upto 2010 and 15% thereafter and for international 15% upto 2010 and 10% after)

Fig.3 Growth of Cargo Traffic
(The growth forecast at the rate of 10% upto 2020)
<table>
<thead>
<tr>
<th>Manufacturing Divisions</th>
<th>R &amp; D Centres</th>
<th>New Divisions</th>
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<td><strong>Aerospace Division, Bangalore</strong></td>
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<tr>
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<td><strong>Industrial &amp; Marine Gas Turbine Division, Bangalore</strong></td>
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<td>Aircraft Division, Nasik</td>
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<td><strong>Airport Services Business Group</strong></td>
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<td><strong>Simulator Business Group</strong></td>
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<td>Engine Test Bed R &amp; D Centre, Bangalore</td>
<td><strong>JVCs</strong></td>
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<td>Gas Turbine R &amp; D Centre, Korapur</td>
<td><strong>Indo Russian Aviation Limited</strong></td>
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<td>Aerospace Systems &amp; Equipment R &amp; D Centre, Lucknow</td>
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<td>Central Materials &amp; Processes Lab &amp; NDT Centre, Bangalore</td>
<td><strong>BAe-HAL Software Private Limited</strong></td>
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Fig. 4 HAL R&D Division

Fig.5 Renaissance of aircraft design : New Projects LCA/ALH/IJT
Fig. 6 Smart structures and materials in Aircraft

Fig. 7 Future Aircraft design projects
Fig. 8 Growth through partnership

- Expertise, Manpower & Resource Shared
- Quicker Concept to Market
- Risk Sharing
- Revenue Sharing
- More effective Marketing

Fig. 10 Synergizing Private Sector Design and Development

Fig. 9 Technology Partners for Design and Development of LCA
Fig. 11 Integration and assembly of components by HAL
Fig. 12 JVCs by HAL

Fig. 13 Aerospace PSU - Private Sector Partnership model

Fig. 14 Synergizing with SME’s for Aerospace Growth

Fig. 15 National Aero Policy and Commission