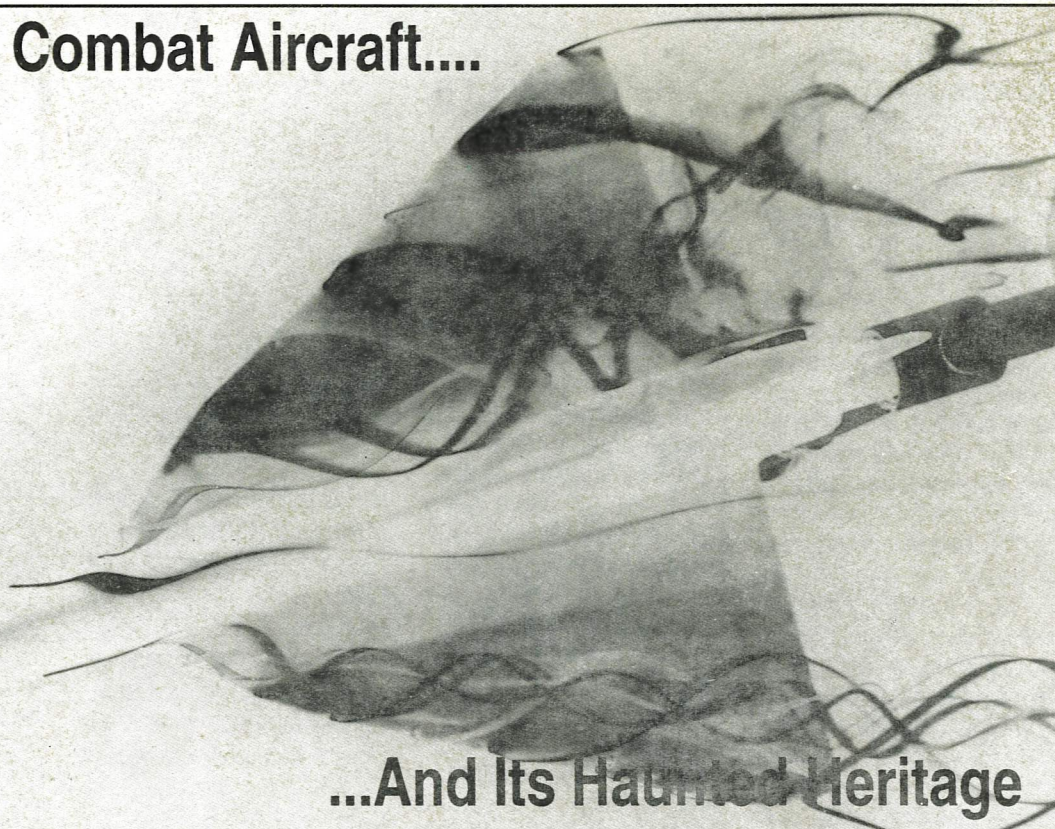


The Light Combat Aircraft....



...And Its Haunted Heritage

The Vayu VI/1997 issue carried a letter from Air Commodore M.N. Kapoor (Retd) to the Editor on LCA developments and also a brief note on the Saab JAS-39 Gripen of Sweden. These reminded this writer of the events that eventually led to the sanction of the LCA programme. Air Commodore Kapoor is correct in drawing attention to the undesirability of giving premature publicity to trivial milestones and setting unrealisable deadlines that are regularly being postponed. As a nation, we tend to be euphoric about trivial things and quickly get depressed for equally trivial failures. Undoubtedly, in due course of time, the Public Accounts Committee of the Parliament, the CAG and others will get into the act and perform a biopsy, if not an autopsy, of the LCA. But it is unrealistic at this stage to cry *wolf*, without giving a decent chance to the developers of this new fighter. It is therefore desirable to briefly examine the LCA's antecedents, its haunted heritage and remind ourselves that "those who do not learn from history are condemned to repeat it".

Development of the Light Combat Aircraft is the most complex, high science, high technology hardware development programme ever undertaken by this country. Perhaps a less complex task, as

in developing a jet trainer aircraft, could have been achieved with greater certainty and in a shorter period of time. But we would have been no better off in bridging the ever widening technology gaps between ourselves and the leaders in aeronautics. Ever since the HF-24's development in 1956, no new programme was approved by the Government, although Hindustan Aeronautics Limited (HAL), did several studies in response to projected Air Staff Requirements (ASR). These studies helped HAL, to some extent, in keeping abreast of the design of advanced technology aircraft, but the funds required to develop new technologies that could have made the studies into concrete realities were just not available. It was against such a background, after a lapse of 25 years since sanction of the HF-24, that development of the LCA was mooted.

The Light Combat Aircraft programme was designed to assure a measure of self reliance and, hopefully, a better bargaining position for acquiring aircraft from abroad. Above all, such a programme would have reduced the danger of other countries holding us for ransom as regards defence and foreign policies in times of conflict. The formidable task of LCA's development was a calculated risk, particularly against the

background in which Indian aeronautics had grown till then. Some of the decisive events leading to its sanction should be borne in mind while assessing its progress.

In the history of Indian aeronautics, two events stand out. First, of course, was that we were late comers in the field. For practical purposes, it was only after the Second World War (i.e. 40 years after the Wright brothers first flew) that any attempt to design an aircraft was made in the country. The HT-2 primary trainer was the first aircraft developed by Hindustan Aeronautics Limited. HAL had been functioning as an aircraft repair base during wartime for the South East Asia Command, almost immediately after it had come into existence. Recognising the decisive role played by the air arm, the super powers went about designing and developing a whole host of new aircraft without depending on others. By the end of the War, the first generation (experimental) jet aircraft were already flying in Europe and the USA.

The second, and perhaps the pre-eminent consideration for India after independence, was the need to defend our skies. We did not have the luxury of having time on our side for indigenous aircraft development. Given the best of

India with Georgia.

According to Mr. A.S. Sethi, the airline's President for Asia and Far East, ORBI Georgian Airways is Georgia's largest and most experienced airline. Georgia is one of the fastest developing nations with a lot of opportunities for India. Also, liberalization has opened up numerous avenues for the Indian business community in Georgia. This has created a need for connecting Georgia with India and "now is the right time for the airline to facilitate air services among the two countries". In addition, the airline would offer convenient onward connections from Georgia to other European destinations.

ORBI Georgian Airways would be deploying Lockheed L.1011 Tristar's on the route. The aircraft are configured for a 345 seating layout in both business and economy class. The carrier is focusing its main marketing efforts in the fast emerging oil-markets in the Caspian Sea with plans for high frequency commuter services offering connections to its Delhi-Tibilisi route.

ORBI Georgian Airways has been operating for the last seven years with scheduled services to Amsterdam, Paris, Prague, Vienna, Athens and Tel Aviv. It is now set to fly on long haul routes making London its main operation base.

Boeing's India Business Relations Intact

"For more than 40 years, Boeing has had a strong business relationship with India, its airlines, and its aviation industry, and that relationship should not suffer as a result of issues today between the U.S.

and India", said Boeing India President Dinesh Keskar on 19 May in New Delhi.

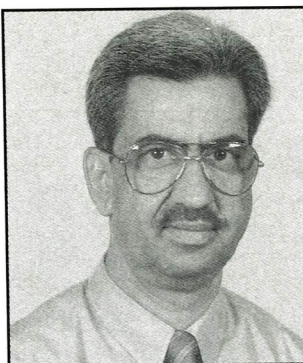
"Boeing has for many years been a partner with India and we intend for that relationship to continue many years into the future," said Keskar. "We are taking a long-term view and believe the relationship will survive and prosper."

In December 1996, Jet Airways ordered ten Boeing 737-series airplanes. To date, three 737-400 have been delivered, with the fourth -400 scheduled for delivery in June. According to Keskar, the delivery will not be affected and will move forward as planned. "Following the June delivery, the follow-on delivery to Jet Airways of its first 737-800 will occur in December 1998, with more -800s to follow, and we are bullish that those additional airplanes will deliver as planned," said Keskar and added that the U.S. sanctions do not affect Boeing's ability to sell aircraft in India.

"The sales campaigns now in progress at Air India and with other carriers will not be affected," said Keskar. "We intend to fully press the case with our customers for Boeing aircraft as a practical and profitable solution to help Air India and other airlines grow their business. The Boeing family of aircraft continue to lead the industry and we need to ensure that our customers in India understand that fact, as well as the fact that we intend to compete strongly to gain this business. We are not conceding anything."

NIAMAR Headed by Bathura

Professor Gurcharan Bathura has assumed



charge of the National Institute of Aviation Management and Research (NIAMAR) in New Delhi. Earlier known as IAM (Institute of Aviation Management), the institute has been conducting aviation-related courses since 1988 when it was commissioned by Dr. S.S. Sidhu, then Secretary Civil Aviation and later Secretary General ICAO.

Interviewed by the VAYU, Professor Bathura described NIAMAR as a unique institution in India catering to the human resource development needs of Airports Authority of India (AAI) besides periodically arranging seminars for international and national participants on various aspects of the aviation industry and its development in India and across the world. NIAMAR is specially committed to conducting Aviation Safety Programmes. Professor Bathura emphasized that under his stewardship, the Institute's immediate goal would be to prepare AAI officials for better customer satisfaction at the airports in India.

Professor Bathura brings with him a reservoir of experience in the field of civil aviation in India. Earlier, as Executive Director, Corporate-Planning of AAI, he was responsible for developing its strategic planning.

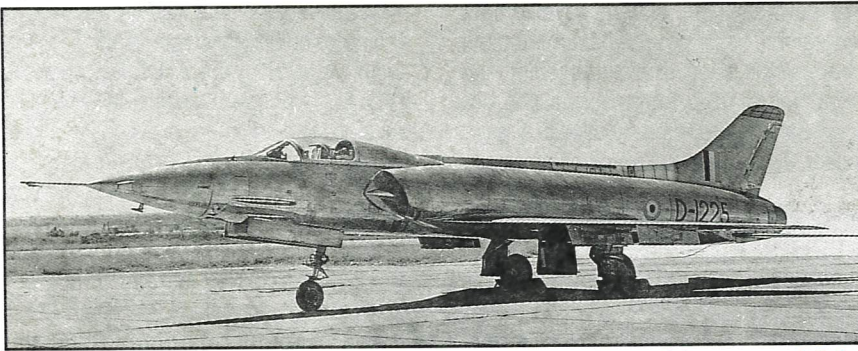
Lufthansa In Consortium To Build New Mumbai Airport

Sources in New Delhi have indicated that Lufthansa's airport development wing is interested in joining an international consortium for building the Rs. 17,000 crore New Mumbai airport, to supplement the present Sahar international airport. It is understood that the Maharashtra government has offered up to 74 per cent stake to private and foreign investment. The state may keep only 26 per cent equity and execute the project, to be completed by 2003-2004, on a build-own-operate-transfer (BOOT) basis.

Lufthansa is reportedly in contact with several Indian and foreign companies with a view to investing in the Mumbai project as part of a technical and financial group.

The new airport is being contemplated in a bid to take the passenger load off the existing airport in the coming decades. The proposed airport is expected to handle 4.1 million passengers initially and by 2019 the handling capacity would increase to 14 million passengers. In the next ten years, according to analysts, the present airport will become saturated—a concern made more serious by the congestion on the city airport road and the slums surrounding the airport—the slum-centric massive human habitation is a safety hazard for flight operations.

The new airport project includes a plan to provide an integrated road, rail and sea link with the city plus Sahar Airport. These high-speed links will be similar to facilities associated with some of the most modern airports in the world.



The HF-24 Marut was a great design, resulting from a bold decision, but its potential was never exploited.

circumstances, it was a daunting task, as it was not sufficient to just develop an aircraft, but we had to develop one which would hold its own in the hostile environment in which it would have to operate. In this situation some European countries were all too willing to sell their aircraft to us. These were, more often than not, soon to be replaced by the next generation fighter aircraft in the countries of their origin. In the order of priorities, the task of developing fighter aircraft indigenously was, so to say, put on the back burner by the Indian Government. The Indian Air Force (IAF) was quite comfortable in this situation, for their terms of reference were to defend Indian skies with the best means available. Building aircraft indigenously was not necessarily one of their priorities.

Licence production of fighter aircraft, in response to the IAF's needs soon took on a life on its own in HAL. Licence production thrived, with no serious thought given to the development of aircraft indigenously. From all indications, inviting the German designer Dr. Kurt Tank and his team from Argentina to India during Krishna Menon's time as the Minister for Defence Production was a political decision. In this was the implicit realisation that time was not on our side to obtain a measure of self reliance and that to bridge the technology gaps and build modern fighter aircraft, we had to seek assistance from abroad. But this realisation did not go far enough. Apparently, the proposal for sanctioning about Rs.5 crore for the development of the reheat version of the Orpheus 703 (B.Or.12) by Bristol Siddeley of Britain to achieve the design objectives of the HF-24 was rejected by the Minister, apparently after NATO countries expressed disinterest in its development. Without this engine, the HF-24, could not meet its

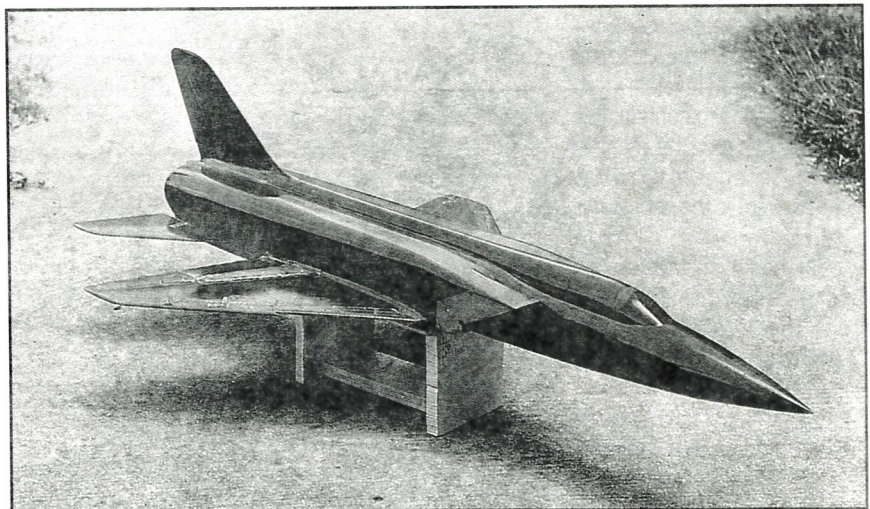
design objectives. While the IAF still accepted the lower performing HF-24, indications were that they were disillusioned with its performance and long down items for maintenance. There were no simple ways of learning such matters, except to try and try again. Indian aircraft designers could not gain such experience owing to the lack of sustained support from the Government.

Theodore Von Karman, perhaps the greatest of all aeronautical scientists put it appropriately. Stressing the importance of experience, he said "good decisions come from experience, and experience comes from bad decisions". Even an "elementary knowledge for building an aircraft to undertake flight", as Kapoor mentions in his letter, has to be backed by an enormous amount of coordinated and relevant R&D for at least the preceding decade before building advanced technology aircraft. This has not been done in the LCA case. Elsewhere in the world it is not uncommon to take such an exercise even up to the level of building technology development aircraft for learning new and advanced

concepts. Such exercises could never be undertaken without full support from the concerned air forces. A visit to the US Air Force museum in Wright Patterson AFB in Dayton (Ohio) gives one a glimpse of the enormous efforts made in the United States. The dependence of the IAF on foreign made aircraft has inevitably bred complacency in this regard.

How short sighted were our decision makers and how much of a short shrift was given by them to learning from experience was brought out forcibly at a meeting of the Aeronautics Committee under the chairmanship of Mr. C. Subramanyam, then a cabinet minister. While discussing the inadequacies of the reheat version of the HF-24 (Mk.1R), the then Chairman of HAL stated that he had been informed by his staff that GTRE's proposed solution for improving the performance would not work. Mr. Subramanyam shot back, "granted it may not work, but how would they know if they do not try it out?"

This succinctly describes the aeronautical scene during the 1970s. It took another ten years before the situation changed to some extent. At a time when the National Aeronautics Laboratory (NAL) was spending Rs. 2 crore annually, HAL's budget for R&D was a mere Rs.20 lakh! If it meant any business, HAL should have been spending at the time nothing less than Rs. 20 crore or more for developing new technologies that could go into the development of modern advanced technology fighter aircraft. In this high-tech field, just to stand **still** we have to keep **moving**. Typically, about 10% of aircraft sales turnover goes into research, design and development in leading countries. Thus



The HF-24 spawned many follow on projects, but these remained only in model form.

by buying aircraft from abroad we were, in effect, supporting foreign aeronautical R&D. (If we spent Rs. 1000 crore for buying foreign-made aircraft, we would then have contributed about Rs. 100 crore to support their R&D for developing their next generation aircraft).

If such investments were not made by us, the IAF would have to import aircraft from abroad, as they could not be expected to fight with aircraft with technologies dating from the days of Kitty Hawk ! But then, by now there were senior Air Force officers (active or retired) who were manning the senior positions of responsibility in HAL. The Design Policy Committee of HAL at that time was overwhelmed with production M.D's, with the lone M.D. Design & Development, fighting a losing battle for funds to take up R&D projects. The results were predictable.

HAL's Board of Directors were not of much help either. The South Block bureaucrats, representing the Government (who were the owners of HAL), argued that investments in R&D would be an infructuous development programme. They had no clue as to what it took to develop an advanced technology aircraft. They had little idea that such developments must be preceded by on-going R&D in this regime of high science and high technology. It was not that HAL's Design Bureau did not make any efforts. Their paper design studies (of GAF, ASA, DPSA, variants of the HF-24 with different engines etc.) however ended up collecting archival dust. In the seventies, there was no will to pursue new ideas, even at the HAL Board level. It would be interesting to contemplate as to what extent the situation has changed since, consequent to the sanction of the LCA.

It hardly needs to be emphasised that there was not much of interaction between HAL and the various R&D laboratories which came into existence following the HF-24 programme. Setting up the R&D laboratories was certainly due to the realisation

that no meaningful aircraft development programme could be undertaken without a strong R&D base. But establishing the three main R&D laboratories did not necessarily improve the situation to a major extent. There was no coordination among



Model of the LCA at the Bangalore Air Show in 1996.

themselves, not to speak of coordinating their activities with those of HAL which did not, in any case, have a corporate R&D culture, much less a base worth mentioning. In fact, there were instances of rivalry among them, instead of efforts towards coordination. Mutual suspicion among them went to such an extent that any proposals to improve the performance of the HF-24 with foreign made engines was opposed, due to the fear that this could well de-rail any indigenous engine development programme. In turn, any

efforts to develop an advanced technology engine of sufficiently high thrust to power a fighter aircraft by the GTRE was opposed by HAL, who questioned its ability to develop such engines indigenously without first developing engines of lower thrust, as was being attempted by HAL at that time. Inevitably, we walked into a no-win situation. A suitable engine from abroad to upgrade the aerodynamically clean HF-24 aircraft was denied and this resulted in the eventual licence production of the Sepecat Jaguar by HAL for the IAF.

It must be stressed that, no matter how competent the aircraft designers are, they are helpless if they do not have access to a suitable engine. With our foreign policies always emphasising the concept of neutrality, a measure of self reliance in aeronautics necessarily demands the ability to design and develop our own engines also; otherwise we can be held for ransom by concerned countries. No matter how competent our designers are, they cannot build an aircraft if they do not have a suitable engine.

Shortly after the Aeronautics Research & Development Board (AR&DB) came into existence (which followed the Subramaniam Committee recommendations), this writer proposed to the then Scientific Adviser to the Minister of Defence that the

AR&DB be made a focal coordinating agency for all aeronautical research & development. It was proposed that research programmes from all the major aeronautical R&D organisations, including those of NAL (with the approval of the then DGSIR), should be scrutinised, approved and monitored by the AR&DB. Although the AR&DB was created as a part of DRDO and chaired by the Scientific Adviser to the Minister of Defence the proposal was not acceptable to its own laboratories ! Further more, the AR&DB did not have any programmes conceived by it whose implementations could have influenced a deliberate



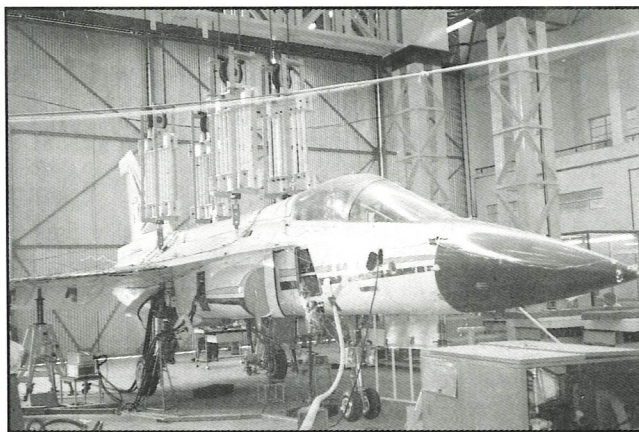
Full scale mock up of the LCA at the Bangalore Air Show in 1993.

and planned move towards self reliance. This, in fact, was the primary purpose for its creation. The AR&DB at that time, was responding to random research proposals that it was receiving mainly from the academic institutions and some research laboratories. As could be expected, these were not necessarily concerned with nor have any coordinated objectives to strengthen the nation's aeronautical base. Neither did the Government provide the AR&DB with adequate funds; its nominal financial support at that time was meant to support research for its own sake. This is not a bad thing in itself, but the very small AR&DB investments could have been used more purposefully to achieve predetermined and planned objectives.

Such a situation could only be retrieved by a direction from the "very top" and the then Prime Minister, Mrs. Gandhi, was seriously concerned : in the mid-seventies, she got the so-called high-powered Aerospace Group setup to consider what could be done. It was a non-starter as there was no agreement among the Group members for an acceptable solution. The final and ignominious notice was served by the civil servants of the Group, who did not like the proposal submitted by the committee's secretariat under the convenership of the then Scientific Adviser to the Minister of Defence. This had envisaged creation of an integrated structure for progressing the development of aeronautics and missiles. The proposed structure presumably drew inspiration from the Space and Atomic Energy Commissions that in the high science-high technology industries, which are paced by R&D, there should be an integrated management system, professionally directed at the highest levels. The reason naturally was that in complex Science and Technology matters one could not manage if one did not have a "feel" for the things that need to be managed. Management of Science & Technology was quite unlike general administration, as virtually every decision proposed to be taken at that level, would have scientific and technical implications.

After considerable persuasion from the technical members of the Committee, the civil servants of the Group from South Block

agreed that there was need for an integrated management system between the R&D and industry. However, the suggestion of the then Chairman of HAL, supported by the other technical members, that a time limit be set for such an integration, was not agreed to by the civil servants. They said that such integration should take its own time and "evolve gradually" and no time limit be set for such integration ! They did not realise that time was really not on our side with the ever widening gaps in technology. Put simply, there was neither the will nor the desire among the civil servants to create an integrated management system. Thus without it, for practical purposes, all efforts by the Prime Minister's Office to force some fresh air into the moribund aeronautical scene, got stalled and then continued in



The first LCA prototype (TD-1) at the development hangar at HAL's Bangalore complex.

this state of suspended animation until the LCA came along.

It appeared that the second alternative to retrieve the situation, at least partially, could have been by obtaining a focal point of action for the aeronautical community to act together within the existing system, than by attempting any major reorganisation as pre-requisite. At the suggestion of the then Scientific Adviser, it was proposed to follow this route. From an informal chat with the then Prime Minister at a conference of scientists and technologists, shortly after the successful launching of the SLV-3, it appeared that the Government would sanction a new fighter programme only if there was unanimity among those concerned. It was also clear that it would be impossible to achieve this objective without the support of the Indian Air Force. Air Chief Marshal

Idris Latif, the then Chief of Air Staff provided that crucial leadership by supporting the LCA programme and by finding an important place for it in the Air Force's Long Term Re-equipment Plan (LTREP) : the CAS breathed life into the moribund aeronautical community. Very fortunately, all the Air Chiefs during this phase of the LCA programme (Air Chief Marshals Idris Latif, Dilbagh Singh, Lakshman Katre and Denis La Fontaine) gave unstinted support to get the LCA going and put its development programme on firm foundation. It was the continued dependence, if not the desire of the IAF for foreign aircraft for over three decades, and a lack of understanding of what was involved in fighter aircraft development among the non-professional decision makers, that had long delayed the

achievement of a measure of self reliance in aeronautics. It was again the sustained vision of these successive Air Chief Marshals at a crucial period, that reversed this unfortunate trend and gave birth to the LCA development programme with positive efforts made to obtain self reliance.

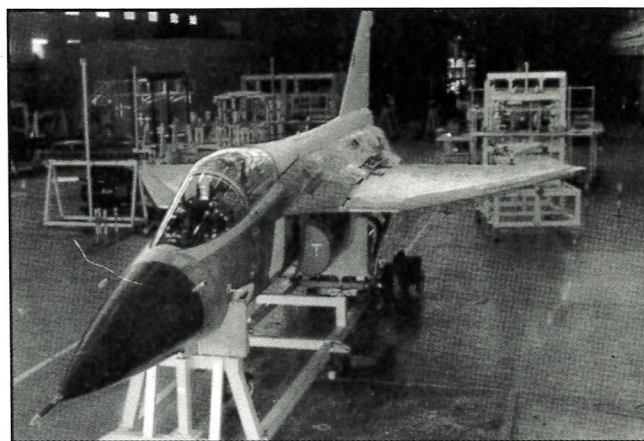
So, the Air Chief Marshals firmly placed the ball in the court of the industry and the R&D, and the DRDO responded by setting up the Aeronautical Development Agency (ADA) whose mandate was to fund, manage and monitor the programme. The ADA was created to bring together the R&D establishments and the design bureau of HAL under one umbrella, to progress the cause of the LCA. The LCA programme reduced the rivalries among the participants and tended to encourage collaboration. But in its wake, the ADA seems to have created its own empire. At a meeting convened to discuss broad details of the ADA structure and the pattern for funding, managing and monitoring the LCA programme, the then Secretary for Defence Production, Mr. Mahesh Sareen suggested (and it was agreed to by the principal participants including the then SA and this writer) that the ADA should be a "lean organisation" and not develop vested interests of its own. It was suggested that the ADA should be small enough to be wound up at short notice. It would be interesting to note that in creating the project management teams

for the SLV-3, ASLV, PSLV etc., the Department of Space would seem to have followed the practice of creating ad hoc teams of personnel drawn from within the organisation, with a project director heading the team and managing the programme, closely monitored at the Secretary's level by his technical secretariat. When the task was completed, the team members would go back to their respective groups, thus adding strength to the group which could then be deployed on other projects. This, incidentally, is the standard matrix method of management of projects by the aerospace industry in the United States.

However, the ADA took on a life of its own, in effect evolving into a design bureau in its own right and, in a sense, competing with HAL's design bureau which had been setup decades earlier to design and develop aircraft in the country. By the very nature of its structure, when the LCA-related activities start winding down, ADA will inevitably follow Peter's Principle to create activity in order to justify its existence! The conceptual studies being done by ADA of 100-seater jetliners is one such case. ADA will tend to create rivalry between the Department of Defence Production and DRDO and raise questions about overlap in the "allocation of business rules" of the Government to its various Departments. In this scenario, one can even conceive the eventual transfer of the HAL design bureau to DRDO, with HAL eventually becoming purely a production organisation with its own production priorities. In this connection, we may recall that consequent to the GTRE taking major responsibility for the development of an advanced technology gas turbine engine for fighter aircraft, HAL took a policy decision to close down its engine design

bureau. Such developments do not necessarily bode well. The research laboratories in the process may well lose sight of one of their important responsibilities, namely, forward looking-directed basic and applied research and preliminary technology development which could become vital inputs for corporate R&D in the industry.

It would now appear that those responsible then did not apply their minds to consequences of the creation of ADA and its long-term role in the scheme of things. Furthermore, with more than full time work in his area of prime responsibility, the concurrent charge of Director General of ADA being handled by the SA becomes difficult, if not well nigh impossible. The position of the Director General ADA is absolutely a full time responsibility, but it would seem that coordination of the aeronautical activity at the highest levels of the Government has become a sacrificial goat for political and bureaucratic expediency. In the process, the primary objectives and cause of aeronautics has become a casualty in protecting vested interests. The "evolutionary integration" then proposed by the civil servants of South Block in the Aerospace Group not only did not take place, but created more uncertainties about the future of aeronautics in India.

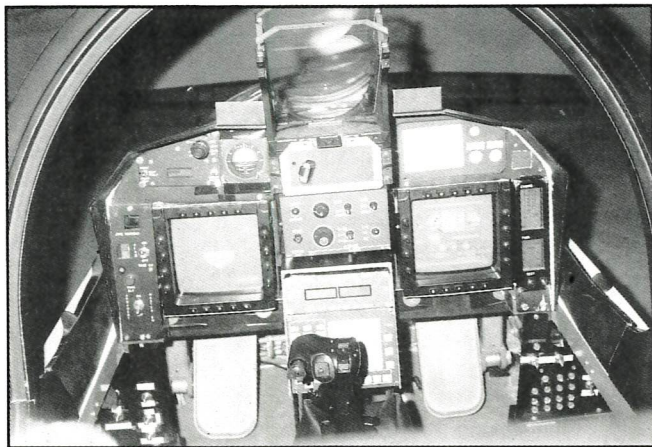


LCA (TD-1) under assembly.

achieve this. Elsewhere in the world, people with a wealth of design experience are treasured as nuggets of gold. It is a well known fact that designers are born and not made. Those who have the ability, will typically go through at least two decades of training, learning the tools of their profession on-the-job under other experienced designers, before they themselves can become competent designers. It was not for nothing that designers like Kelly Johnson of Lockheed's "Skunk Works" in the USA kept going at their jobs, long past traditional retirement age. It is unfortunate that India's senior policy and decision makers have not understood this fundamental point.

It is the enormous amount of research, development, design and testing and testing again, that builds up experience and assures operational reliability in an aircraft. Inadequate prior preparation before the LCA was sanctioned, and easing out of some talented designers plus routine retirement of experienced personnel is not the way to build reliability into the LCA. It will clearly take that much longer now to build LCA into a reliable weapons system.

One way in which we could have reduced the time for development—and obtained greater assurance of reliability in such background—was to seek a foreign partner whose requirements were substantially similar to ours. It would also have substantially reduced the time and cost of development. Sweden, with its JAS-39 (Gripen) programme, with similar Air Staff Requirements, could have been an attractive partner. But Saab discontinued discussions with us as they did not wish to wait much longer after their Parliament had given approval. It was not even certain at that time, that our Government would even



Representative LCA cockpit at ADA.

To put it mildly, the LCA's development is an extraordinarily complex task. This writer recalls that during his visit to NAL, when asked what the Air Force expected in the LCA development, Air Chief Marshal Dilbagh Singh stated "reliability, reliability and more reliability". It takes an extraordinary amount of effort and experience to

approve of the LCA programme. It is interesting to note from the same issue of *Vayu VI/97*, that Saab has already delivered 45 Gripen aircraft out of a total of 204 ordered. We are still some time away from even the start of LCA flight testing, some 15 years after launching the programme.

Proposals for launching the LCA programme also coincided with concurrent efforts from some quarters to integrate R&D and the industry, much along the lines of the Space and Atomic Energy Departments with a dedicated Department servicing an Aeronautics Commission and with a technical person heading it. This was to have two wings under it, one responsible for research, design and development, headed by a technical person, and a production wing headed by a serving Air Marshal. However, the then Scientific Adviser was not keen on this restructuring, perhaps as he felt this would "weaken" his office. The PMO was interested, but could not do much without

support from the concerned Ministry. It was not obvious to the concerned people in the Ministry that in this field paced by R&D, integration through restructuring would certainly have led to a more healthy and viable aircraft industry. The fact that the Department of Atomic Energy without BARC or Department of Space without VSSC would be toothless tigers, did not make much of an impression in these quarters. This in spite the fact that at that level, an understanding about the broad technical aspects of aeronautics would be essential to evolve realistic policies and to take sensible decisions. Protecting vested interests apparently became more important than protecting the cause of aeronautics. These events sadly demonstrated that it is easier to create new departments of Government than to restructure and re-group existing ones!

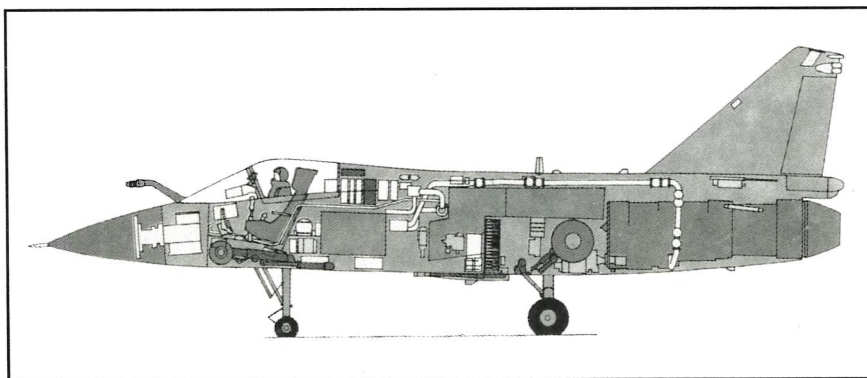
It was thought at one time at senior levels of DRDO that a demonstrator variant of the GTX engine under development and funded by them, was to be the powerplant for the LCA. Suggestions at the time that the variant of GTX engine intended for LCA

(and subsequently christened the *Kaveri*) should also be funded, managed and monitored by ADA to ensure proper engine-airframe compatibility to avoid repetition of the fiasco in development of the HF-24 (Mk-1R), were summarily rejected by the Scientific Adviser. It may be recalled that the 20% increase in thrust demonstrated by the reheat variant of Orpheus 703 on the test bed by GTRE was washed out after installation in the HF-24 airframe, owing to improper redesign of its aft end. One would hope that when the *Kaveri* is ready for installation in the LCA, it would be a one to one substitute for the GE F.404, the power plant around which the LCA is currently being developed and would not demand

variants of the LCA and other aircraft later. This is not an unusual thing to do and nothing to feel ashamed about. This would have necessitated placing our engineers and designers with the foreign contractors to work on LCA-related tasks side by side and learn-on-the-job. NAL had done so when it gave a contract to a Canadian company for its 1.2 metre trisonic tunnel. Department of Space had done it by placing its people in France to learn about liquid propellant rocket technology.

The second alternative was to develop, from scratch, all the necessary technologies indigenously, with the inevitable delays and slippages of projected time schedules owing to insufficient prior R&D and thus suffer consequent delays in entry of the LCA into squadron service. In the event, ADA would seem to have taken the middle path, with contracts abroad for the Fly-by-Wire (FBW) control systems and some large components (skins) for the CFC Wings

etc. The responsibility for the systems integration, flying the aircraft and its flight testing and (hopefully) its production however rests with us. Incidentally, a proposal was made in the early eighties at an HAL Board meeting that we should mount a programme to understand the design and development of the fly-by-wire control systems. The proposal was to convert an HF-24 into a flying test bed by suitably establishing it and developing a fly-by-wire control system first. This suggestion was made following a visit by an Indian team to some of the European aircraft manufacturers who were then undertaking similar studies. A joint proposal was made by the HAL design bureau and NAL. HAL management still did not take a view on the matter, even after it was brought to the attention of its board. It was clear by that time, that the LCA would have to have relaxed static stability and a fly-by-wire control system in addition to fairly extensive use of carbon fibre composites (CFC) in the airframe structure to respond to the performance demands of the Air Force for the potential LCA entering service in the



Cutaway drawing of the LCA, showing major system layouts.

expensive airframe modifications involving drag penalty. The fact of the matter is that policy decisions to tackle such problems and their implications would be obvious only to those who have an understanding of these matters. Otherwise it would be easy to commit horrendous errors in decision making. Experience all over the world indicates that developing an advanced technology gas turbine is inherently more complex and involves more trials and testing and it is experience that determines the final results. As this is the first time India is developing an advanced technology gas turbine, we should have no illusions about the complexity of the task that we have undertaken.

Two alternatives were available for development of the LCA. One was to retain responsibility for the design leadership for which we have adequate ability and obtain from abroad all those technologies which we did not have, so that we could build the LCA in time to achieve the initially projected schedules. We could then have simultaneously planned for absorbing the imported technologies, so as to build

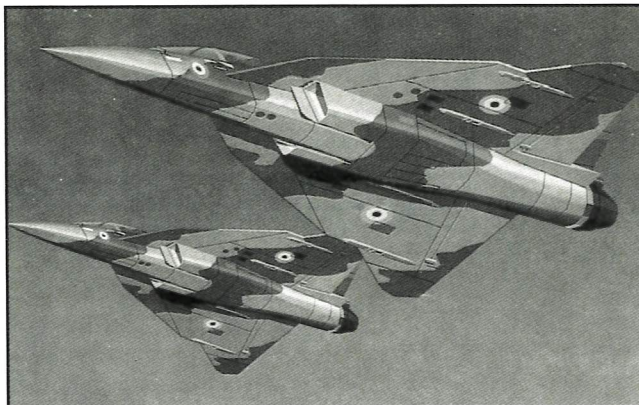
early nineties. The problem about use of composites was less serious, in that NAL had already gained considerable experience in handling these analytically and developing fabrication techniques for use of composites, in anticipation of things to come. What NAL lacked was a sufficiently big autoclave to cure CFC wing skins for which ADA had to place orders abroad.

Being a high science and high technology endeavour, that too with divided responsibilities between the industry and the R&D and without a clear delineation between them, the LCA's development has become an even more complex challenge. The situation reminds one of the aphorism "victory has a thousand fathers but failure is an orphan". It is a Faustian situation without any simple alternatives, if we desire to obtain a measure of self reliance, not wholly, but at least substantially. What a successful LCA offers India is a position of strength and confidence in that when we face the moment of truth, we know we can do things by ourselves.

We should have no illusions about the complexity of the task, and possible failures primarily because of past acts of omission and commission. The Space Department did not close the SLV-3 programme when they met initial failures but persevered. They analysed the problems, rectified errors in design and proceeded ahead from the SLV to the ASLV, PSLV and are now developing the GSLV. Some of these too had problems and in fact failed during their first launches. With all the experience they had, Sweden had two accidents during development of the Gripen. Airbus Industrie had similar accidents in the development of the A-320 Airbus, with its FBW control system. Several aircraft developed in France, the UK and USA in recent times,

with full support from their Air Forces, did not go beyond the prototype development stages. Such experiences are not unusual, but they have enabled development of new technologies and kept them abreast of their adversaries.

In May 1985, when this writer submitted the feasibility study report on the LCA to the late Air Chief Marshal Lakshman Katre,



Artist's impression of the LCA (1992) showing the cranked delta wing shape as initially designed by the MBB consultants....

the CAS asked whether the Air Force would henceforth be prevented from importing fighter aircraft from abroad. I replied that his terms of reference were to defend our skies and not necessarily or only by Indian-made aircraft. It is hard to place such constraints on the Air Force, but it is equally

of weakness whenever our national security is threatened. It is important to note that the United States has already prevented Russia from giving India rocket technology based on liquid oxygen and liquid hydrogen. The Department of Space then apparently decided to develop this on its own instead of throwing in the towel. In aeronautics we can and must do no less.

The Indian Air Force has given India's aeronautical industry an opportunity to learn to build advanced technology fighter aircraft. We should not make this the last opportunity for the aeronautical community as such. The IAF too should become an active and, above all, a committed participant in such a challenging exercise of LCA development to make it certain that it will not become a lost opportunity. The IAF, the politicians including the Public Accounts Committee of the Parliament and the office of the Comptroller and Auditor General (CAG) too should appreciate the complexity of the problem. The possibilities of failure, including perhaps even the loss of one or two prototypes of the LCA in the early stages of flight testing, are no less here (if not more), than in the development of space launch vehicles by the Department

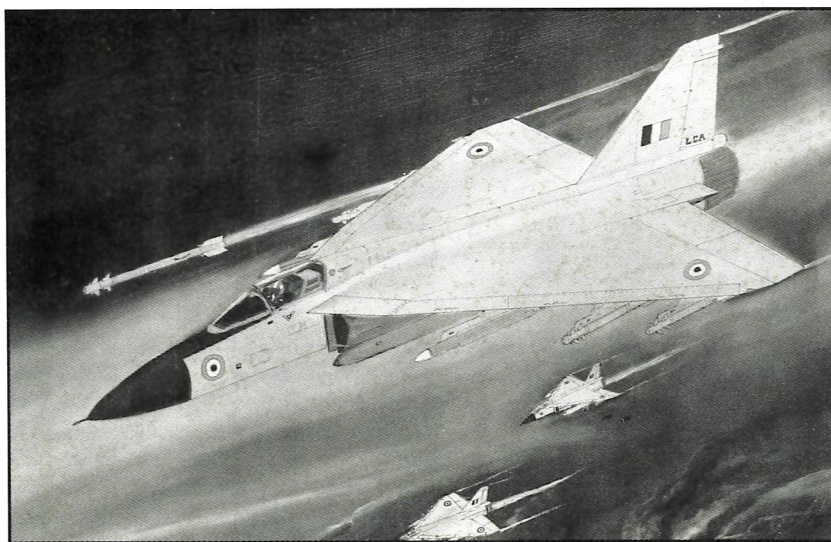
of Space. We have to proceed ahead with determination and should not lose heart when we face failures. For the eventual success of the LCA, there are no short cuts nor simple solutions.

It will be good to remember the cautionary note sounded by the Noble Laureate Richard Feynman as a member of President Reagan's committee to investigate the causes of the catastrophic failure of the shuttle *Challenger*. "For a successful technology, reality must take precedence over public

relations, for nature cannot be fooled". For the success of LCA, there are no short cuts nor simple solutions.

Dr.S.R.Valluri

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...and artist's impression of the LCA (1998), showing the straightened-out wing leading-edge as designed by the Dassault consultants.

important that the Air Force holds the hands of the designers at this crucial juncture if we want to obtain a measure of self reliance in this unipolar world. India is too big a country to deal with others from a position