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Dear Dr Ramachandran,

3rd February 2007.

I read with considerable interest your article in Hindu on the DRDO. Having very closely interacted with this organization for over two decades in the field of aeronautics, I thought I would put down my experiences in writing . Many of my colleagues have suggested that I should do this. The result is chapter three in book I wrote title "Events in Life" purely for private circulation . I am enclosing herewith the relevant chapter for your information.

I must add that it is based on firsthand information and personal contacts with people, and is not necessarily written to please people. Therefore, while you are welcome to use this information in any manner, I will be thankful if you do not directly attribute it to me. You can certainly say the information is from informed people.

I will be glad to talk to you and give any clarifications that you seek. You can contact me either on the phone on the e mail given above if you desire . I will be thankful if you kindly acknowledge receipt .

With good wishes,

S.R Valluri

S R Valluri.

Chapter 3

The LCA Program & the Role of the Aeronautical Development Agency

S. R. Valluri

It is said that those who can't remember their past will be condemned to repeat it. This is true in the field of aeronautics during the last sixty years or so in our country. India's involvement in aeronautics started in a modest manner when what is now Hindustan Aeronautics Limited (HAL) was transformed from being a repair base for the South-East Asia Command to an aircraft manufacturing center after the war. It was to respond to the needs of the Indian Air Force and functioned mainly as a production agency under license. Its work in converting the old DC3 into civilian aircraft gave an initial impetus to starting a number of commercial airlines, which were soon integrated into what is now the Indian Airlines. The earliest attempt to develop indigenously an aircraft in HAL was the HT2 designed by Dr V M Ghatge, then Chief Designer. No serious attempt was made to indigenously develop any military aircraft, till the government decided to invite Kurt Tank and his German team. The result was the HF24, an aerodynamically clean aircraft designed for supersonic performance. It never attained its design performance due to the inadequate power of its two Orpheus 703 engines. The aircraft was designed around one Bristol Siddeley BOR12 engine, yet to be developed. It was a reheat variant of the Orpheus 703 engine being produced under license to power the Gnat and later the de-rated version to power the HJT16 developed by Raj Mahindra. This was a program initiated by Dr V M Ghatge. Raj did his studies in Imperial College in London and worked for some years at De Havilland and Napier Aircraft companies before returning to India.

Bristol Siddeley hoped to sell this reheat variant to the NATO countries also. Apparently they were not successful. They approached Mr V K Krishna Menon, then Defence Minister, and apparently offered to develop it for use in HF24 and asked for Rs 5 crores (Rs 50 million) for development. The Minister rejected it. Looking back, it was a fatal error in judgment, for the HF24 never achieved its designed supersonic performance. It was a classic example of decision making by people who did not understand the implications of their decisions. This was repeated time and again by people in the South Block.

GTRE, then a fledgling research laboratory set up by DRDO under AVM Roy Choudhuri as its Director, took on the responsibility for developing the afterburner to fit it to the Orpheus 703. He demonstrated successfully its design performance of 20% increase in thrust on the test bed when operating in the reheat mode. HAL had the responsibility to suitably modify the HF24 to accommodate the afterburner. Instead of redesigning the fuselage to accommodate the afterburner to reduce any potential increase in drag to a minimum, S C Das, then in charge of the program, decided to fit the afterburner with a sudden increase in the aft end area of the fuselage. This resulted in an increase in drag, which substantially washed out the increase in thrust obtained by the afterburner. HF24 reheat version was closed shortly thereafter when Suranjan Das, the Chief Test Pilot of HAL, died in a test flight of the HF24 with the afterburner. Apparently, its cockpit canopy suddenly opened as he was taking off. Licensed production of other military aircraft continued in HAL.

This was the situation when Mrs Gandhi constituted the Aeronautics Committee in 1969-1970, under the chairmanship of Mr C Subramanyam, former Cabinet Minister at the Center, to determine what had gone wrong in the aeronautical industry, and sought recommendations for changes, with a view to achieving some self-reliance. The Committee constituted a number of sub-committees to study various aspects of the problem. I was nominated as the chairman of Study Group No. 5, to look into the issues pertaining to research and development. Thus started my involvement in matters relating to problems of policy that affected the cause of R&D in general in the country, and aeronautics in particular.

I sought an appointment with Mr C Subramanyam, and asked him how I should proceed. He told me to bring out facts. I told him that facts might hurt some people. He said that it did not matter, and he needed the facts to make appropriate recommendations. As could be expected, most of the time of the committee was taken up with the problems related to the development of HF24. Then started my problems.

I got a telephone call from AVM P C Lal (subsequently Chief of Air Staff), then heading HAL. He desired that I should not pay too much attention to this problem. I told him about the instructions from the chairman. I got a similar call from Dr Ghatge with a similar answer from me. Then the secretary to the Committee, Mr S Krishnaswamy, at that time a joint secretary in the Department of Defence Production, attended one of the meetings, and asked me halfway through, whether we should examine the problems in such detail. I asked how else we could establish facts. He never came back again. I requested Dr R Narasimha and Raj Mahindra to determine the increase in drag due to changes in the design of the aft end. They studied the problem in some depth. In essence, they established that the sudden change in the aft end increased the frontal area of the fuselage, which essentially washed out the 20% increase in thrust from reheat.

Mr Subramanyam then called me to make a presentation of the findings to his committee. I reported that our studies established that the increase in thrust due to the afterburner demonstrated on the test bed was washed out due to the mutilation of the aft end of the fuselage. AVM Lal was unhappy, and stated that his staff gave a different estimate. The chairman then asked him how else facts could be established, if not from the findings of an independent committee.

The Aeronautics Committee in its report recommended that HAL should take up the development of a combat aircraft, a short take-off and landing (STOL) aircraft and a helicopter. It took ten years for the government to sanction the development of a combat aircraft. The STOL never saw the light of day. The helicopter development was sanctioned soon after, with Mahindra handling the program in its initial phases. The Air Force released a number of Air Staff Requirements over the years. Feasibility studies were conducted by HAL on all of them, with extensive wind tunnel tests in NAL to optimize the aerodynamic configurations. Nothing came out of them, and licensed production of aircraft developed and manufactured abroad became more a rule than an exception. The Air Force was comfortable with the situation. They lacked confidence in the ability of HAL to successfully see through the design and development of a fighter aircraft within the country. The bureaucrats too were satisfied, because then they did not have to answer any Parliament questions, as they merely approved what the Air Force wanted. Meanwhile, the research labs were busy conducting "forward-looking research" and they did not have to respond to any problems generated by the industry. The industry did not have any, as they were using "proven technology", even when it was obsolete in the country of its origin. The academic institutions were taking up research inspired by a study of scientific papers in foreign journals. As stated earlier, the loop of knowledge was not closed, each going its own way, and none interacting with the other. In essence the situation was pathetic as far as the cause of self-reliance in aeronautics was concerned.

During the time of Dr Nag Choudhuri as SA and Dr Satish Dhawan as the executive delegate from India for the Commonwealth Advisory Aeronautical Research Council (CAARC), I was nominated as the coordinator for research in materials among the CAARC countries, and subsequently took over from Dr Dhawan as the executive delegate from India. It is to be noted that among the member countries, UK and Canada were members of the Advisory Group for Aeronautical Research and Development (AGARD), an active body under NATO to coordinate R&D among NATO countries, and their involvement in CAARC was less than enthusiastic. Research programs were being conceived, obeying Parkinson's Law to justify the existence of CAARC. It provided opportunities for travels abroad for the delegates, and not much else. The programs conceived were by and large trivial. It became clear that CAARC was not serving any useful purpose. It was wound up.

I continued to feel that unless there was coordination of research efforts with a view to responding to the long-term projected requirements of the aircraft industry, there would be no change in the then prevailing situation. As mentioned already, with the permission of the then DGSIR Dr Nayudamma, I approached the then SA to the Minister of Defence, Dr B D Nag Choudhuri, who succeeded Dr S Bhagavantam as the SA, and proposed that NAL, ADE and GTRE should coordinate their efforts to establish a strong R&D base in aeronautics in the country. As stated already, the idea was that in our respective fields, we needed to ask some fundamental questions: Where are we now? Where do we want to go? Why do we want to get there? And finally, how do we want to get there?

Answers to these questions were essential, if the R&D institutions were to contribute in a meaningful manner to aeronautics, with its long gestation periods for the development of successful technologies. For example, if the Air Force today issues an ASR for the development of a combat aircraft required ten years from now, to respond to the threat scenarios likely to be faced at that time, the R&D institutions should have already developed the technologies needed to build such an aircraft. In other words, these institutions need to have at least a twenty-year perspective to plan their research programs. The output of these institutions would then become a desirable input downstream to the corporate R&D, whose output in turn would have to become an input to the design bureau of HAL. ADE rejected the idea of coordination of effort. Not only that, the governing councils that existed then to oversee the functioning of the DRDO labs were subsequently abolished. DRDO itself had no clue to the kind of forward-looking R&D that its labs working in the field of aeronautics should be taking up. Put plainly, there was jealousy among the research labs, and no coordination among them for the common good of aeronautics. Instances were known where research labs were duplicating their efforts, instead of reaping the benefit of mutual interaction.

When Dr Nag Choudhuri laid down office as the SA, Prof M G K Menon, the distinguished physicist from TIFR, succeeded him. The situation in the field of aeronautics did not change. What it required was a deep understanding about what was needed, and steering these R&D institutions and the corporate R&D towards that objective. Good as the scientific advisers were, they did not understand what needed to be done to build a strong aeronautical base. They continued to fund the institutions based on previous years' actual expenditures, and merely supported the research programs proposed by these institutions. They did not have any long-term goals of their own to direct the activities of these institutions. The situation in NAL was basically no different. To the extent that it was not vertically integrated with a specific user agency, its R&D programs also lacked potential user focus. Its headquarters knew even less about its research programs. But it was generally acclaimed as the best engineering laboratory in the country for the quality of its research. As Dr Dhawan put it, "NAL is a beautiful bride, all decked up, and nowhere to go". It was not a master of its destiny.

This meant helping HAL wherever we could in the feasibility studies of the ASRs and taking up forward-looking research and technology development, in the fields related to aircraft structures. As far as aerodynamics was concerned, we were quite well up. I felt that we needed to concentrate on composite technology development, and in particular how to handle it analytically, and how to design and build composite structures. As carbon fibre was expensive, we learned these principles and techniques using glass fibre. As stated already, NAL later was given contracts for developing many structural components based on carbon fibre composite technology after the LCA program was launched, to make us less dependent on others for them.

GTRE continued to study the design and development of gas turbines. It did not get as much support as it required for making any significant progress, although AVM Roy Choudhuri, the Director, was highly committed to developing gas turbines. As a last resort, he apparently subdivided his research programs for engine development, and sought separate funds for R&D related to the compressor, combustion chamber and turbine, etc. Having been a member of the GTRE governing council for some time, I appreciated the problems he was facing. What he had hoped to do was some day to integrate knowledge obtained by a study of these various subsystems to develop the experimental gas turbine GTX35. Had the office of the SA been aware of the complexities in engine development and the importance of such engines for fighter aircraft development, it would certainly have given full support to GTRE. Tragically, that was not the case. In fact, as it turned out later on, Dr Raja Ramanna as the SA eased him out of his position instead of giving him an extension. It was a tragic error of judgment. The fact is that no matter how good your aircraft designers are, if you do not have a suitable engine, you cannot develop your own aircraft. Our potential foreign suppliers held us to ransom by denying us engines that would have improved the performance of HF24. They wanted to sell their aircraft to us, and they did so, subsequently.

The Aeronautical Development Establishment (ADE) was in an entirely different situation. Its activities were spread out, with no clear focal point. They were even designing passenger seats for commercial aircraft. Although the SA specifically assigned the responsibility for aeronautical systems to them, they did not seem to have paid much attention to studying the problems of relaxed static stability and the fly-by-wire control system development. Neither did the office of the SA take the initiative to ask ADE to take up R&D in FBW control systems, its assigned area of responsibility. To me, it was clear that when the Air Force issued its next ASRs, they would demand a thorough understanding of this field as well as carbon fibre composite (CFC) technology for making airframe components. The result was that when LCA was sanctioned, we did not have the FBW technology within the country, while NAL was prepared to handle CFC technology. More later about this

problem.

Shortly after this assignment of responsibilities, it so happened that Mr P N Haksar, Principal Secretary to Prime Minister Mrs Gandhi, was visiting Bangalore early 1976. Air Marshal S J Dastur, the then Chairman of HAL, and I called on him and told him that the progress in aeronautics was not satisfactory, and that something should be done. Perhaps some others also might have conveyed to him the same impression. The result was that Mrs Gandhi constituted the Aerospace Group to look into the matter, with wide-ranging terms of reference, including the possibility of restructuring the organizational structure of aeronautics in the country. The committee consisted of Prof M G K Menon, SA, as the convenor, with the other members being Secretary, Defence, Secretary, Defence Production, the three Chiefs of Staff of the armed forces, Prof Satish Dhawan, Secretary, Department of Space, Dr A Ramachandran, Secretary, Department of Science and Technology, Air Marshal S J Dastur, Chairman, HAL, and me. The committee held discussions from 1976 to 1978. Also present was Air Marshal Narasimhan, Secretary to the committee.

At its first meeting, Air Marshal Narasimhan presented a proposed organization chart for restructuring the various aeronautical institutions to obtain a measure of coherence in their activities. There were reservations from the Secretaries in the Defence Ministry from the very beginning. The Secretary, Defence Production stated that if the annual budget in aeronautics was above Rs 1000 crores (Rs 10 billion), integration should take place. I pointed out that it was already in excess of that. There was silence. Then he said that he had been negotiating with some foreign companies, and so it was not opportune to do it then. I pointed out to him that the information needed to hold such negotiations would not be with him, but would be with the staff down the line in the department, and that if he were to be transferred, these staff would brief his successors. There was again silence, and the meeting adjourned shortly thereafter. This set the trend for all the discussions that followed. The scientific members in the committee were clear that integration should take place, and Air Chief Marshal Moolgaonkar and Air Marshal Dastur supported it. The Air Chief proposed that an Air Force officer should head the proposed Agency. Secretary, Defence stated there could be differences of opinion about that. After further discussions, the Secretary, Defence reluctantly agreed that integration would be needed. Immediately, Air Marshal Dastur requested him to set a deadline for integration. He was not willing. For all practical purposes, the very concept of integration was stillborn. Some time later, Dr Raja Ramanna succeeded Prof Menon as SA.

Shortly before Prof Menon left some time in 1978, an important development took place. It could have adversely affected the destinies of NAL. Morarji Desai, the then Prime Minister, wanted to dismantle the CSIR and distribute the bulk of its laboratories to other government departments. This was apparently inspired by Dr Atma Ram, former DGSIR. Dr A Ramachandran was the DGSIR when this proposal was mooted, and I happened to be a member of the Governing Body as well as of the Society of CSIR, presided over by the PM. It was proposed to transfer NAL to Defence. I asked Vivek Sinha, then Director, Aeronautics in DRDO, what the probability was that an Air Force officer who would not necessarily have relevant experience would succeed me. Vivek replied that such a possibility could not be ruled out at all. NAL required a specialist who had a good understanding of the relevant R&D and aspects of design of aircraft to direct its destinies. I then asked Dr Dhawan whether Space would be interested in taking over NAL, if it was to be transferred, as the culture in Space was very similar to that of NAL. He stated that he did not need NAL and the only thing for which Space would have to depend upon NAL was access to the 4 ft tunnel, and that NAL was in no position to deny it. He further said he was not going to ask the PM for NAL and that the PM did not offer NAL to Space. He was correct in his assessment. NAL needed Space more than Space needed NAL. I then approached Dr Ramachandran and said that he had to fight against NAL being transferred to Defence. He told me to keep quiet at the Society meeting when the item came up for discussion. There had apparently been a change in the PM's view. It was decided to transfer the museums but retain almost all other labs within the fold of CSIR. NAL escaped being transferred to Defence by the skin of its teeth, so to say. It would have been an unmitigated disaster, considering how the DRDO laboratories were being run at that time. Had there been an integration of R&D and the industry under an aeronautics commission in the Defence Ministry, along the lines of the Space Commission, it would have been an altogether different situation. Sadly, it was not to be.

In an informal chat after he took over as SA, Dr Ramanna said that perhaps all was not lost, and if we did not succeed in formal integration, we could still try to do it through a project, and suggested that I should approach Air Chief Marshal Latif, then Chief of Air Staff. I had interacted with the Air Chief on several occasions earlier, while handling problems for the Air Force, and NAL established good credentials for delivering results. I told the Air Chief that if it was the policy of the Air Force to defend our skies with imported aircraft or aircraft built under license in the country, the research laboratories would do well to take up some

other work. I stated that if the Air Force were to support the development of a fighter aircraft in the country, their ability to defend our skies would not be compromised, because the country was already producing MIG 21 aircraft under license, and the chances were very high that we would soon be producing under license the Jaguar, and even the Mirage 2000 might be added to the Air Force fleet. So the time was opportune to take up the design and development of a combat aircraft.

The response of the Air Chief was that if I were to be behind the program, he would support it. I told him that I would be fully involved in it. I requested him not to give a specific Air Staff Requirement (ASR) but give an Air Staff Target (AST), and said I would constitute an integrated team cutting across artificial barriers and involve the industry, the R&D laboratories, academic institutions, and of course the Air Force. He was fully supportive. The aeronautical community owes a debt of gratitude to him for his vision and support. I reported to the SA what had transpired. He said that we should invite foreign consultants also to take up feasibility studies of the AST. We invited BAE, Marcel Dassault, Dornier, MBB, and the Italians. The Russians said that they would be "disinterestedly interested" and answer any questions we might wish to pose. They were a party who would be directly affected if the LCA program were to succeed. We found that the Italians did not have the crucial technologies needed to build the LCA. In fact, during the briefing, Mr Rajiv Gandhi, who was then a Member of Parliament, asked me what the possibilities were of the Italians providing the necessary know-how. I told him that we had invited them to assess their capability and found that they did not have the necessary technologies needed for the development of the LCA. Yugoslavia was keenly interested in collaboration but it was a country that was about to break up. Mr Rao Sahib, then Cabinet Secretary, advised against any collaboration. His advice was correct. Some time thereafter, it started breaking up. In our discussions with these companies, we found that while BAE, MBB and Dornier were open and fully answered our questions, Marcel Dassault were less than honest. They were making factually incorrect statements. In an aside, one of their members told a senior staff member from NAL sitting next to him, "You can discuss here all you wish. But we are going to get the contract". And they did initially get the contract. It would seem political considerations weigh heavily in such matters.

There are a couple of interesting anecdotes worth relating here. When the LCA integrated design team was in Germany for discussions with Dornier, in a casual conversation I asked Johnny Green, who subsequently retired as an Air Marshal, whether a person like me with my qualifications and experience in aeronautics, could ever become a Chief of Air Staff. There was a smile, which covered the dismay on his face, that I could ever ask a question like that. I told him that I would not be fit to occupy such a post, as it required a lifetime of direct and specialized experience in that field of professional endeavour, which I did not have. I then asked him the rhetorical question, how an equally demanding and specialized field like aircraft research, design, development, and manufacture could be handled by an Air Force officer, or for that matter by any administrator who did not have a deep understanding of the field. Of course, there was no answer, and there could not be any. Each of these specialized fields would require a lifetime of relevant experience, which even the general administrators, good, as they are in general administration, do not have. This has been a problem that has haunted the aeronautical scene for half a century and prevented us from obtaining even a measure of self-reliance. Shortly after a meeting called by the then Secretary, Defence Production adjourned, in an informal chat, Air Marshal Zaheer asked me how I succeeded in making people from different aeronautical organizations work together. I told him that everybody would be benefited when a program such as the LCA was launched. He shook his head with a sense of surprise and said, "All these days we were able to get what we wanted from abroad by dividing the R&D and the industry. It is amazing that you were able to bring these institutions together". I succeeded because nobody's interests were sacrificed by launching such a program.

The feasibility studies were interesting. We found that as far as the conceptual design of the aircraft was concerned, we were in no way behind these companies. But what they had, and we did not have, were the technologies that were needed to build the LCA. These were, primarily, aspects of relaxed static stability and FBW systems. We did not need any know-how from abroad to build composite structures, but we lacked at that time a sufficiently big autoclave to produce CFC wing skins for the LCA. These were imported from Italy, but NAL subsequently designed an autoclave to cure such large components and supplied it to HAL.

While these studies were going on, some political developments took place. The elections were on. Mrs Gandhi was fighting to get back to power and wanted to make the acquisition of Jaguar aircraft an election issue, stating that it was a bad choice. I got a telephone call from the office of the then Defence Minister, Mr C Subramanyam, asking me to come immediately to Delhi.
I was not told the reason. I met Dr Ramanna, the SA, also at the airport. He too had been called back. We were directly taken to the Air Chief's residence. Air Chief Marshal Latif then told us that the Air Force acquiring the

Jaguar was based on a detailed study of the offers and that there were no underhand dealings in its acquisition. He wanted us to study all the relevant files and draw our own conclusions. The following morning, we met the Defence Minister. He too said the same thing. He asked Air Marshal Gole, then in Shillong, to come back and assist us, and opened up all relevant files. Dr Ramanna told me that he knew nothing about aeronautics and therefore, did not wish to participate in the investigation, and wanted me to handle the issue. This was revealing. He was an outstanding nuclear physicist and the prime mover behind India's 1974 nuclear explosion. In matters related to aeronautics, he was not alone. I knew virtually all the SAs from the time of Dr Bhagavantam and had interacted with them on matters related to aeronautics. As stated already, aeronautics is a highly specialized field, driven by forward-looking high science and high technology, with long gestation periods. Each of these Scientific Advisers was professionally highly competent in his field of professional endeavour. But not one of them had any understanding of aeronautics to draw any sensible conclusions, and much less take decisions that would help the cause of aeronautics. They were handling responsibility for administering a field about which they knew little. The decisions taken by some of them turned out to be disastrous, as we shall see below.

Frankly speaking, the situation in CSIR was no different and in fact, may be considered worse. Its laboratories were not vertically integrated with any hardware development organizations. They are so diverse in the scope of their activities, that no DGSIR would ever be able to have a deep understanding of all their activities. To build some accountability into their activities, Dr R A Mashelkar made external cash flow a measure of their utility to the community. But no DGSIR has been really equipped to understand what goes on in NAL. NAL was pretty much left to itself, and its performance was judged by its external cash flow, which was good because of the LCA program. The real problems of NAL surfaced when it took up the development of the Light Transport Aircraft (LTA), SARAS, to obtain a measure of control over its destinies. Indications were that the DGSIR was let down by NAL management and the committee he appointed to report on the progress of the LTA development. More about this issue, later.

I studied the files relating to the Jaguar. Three aircraft were considered. One was the Viggen from Sweden, the second was the French Mirage, and the third was the Jaguar. The Viggen was out of the running from the beginning because it had an American engine which would not be available to us; the French Mirage offered to us was an older generation aircraft; and the Jaguar was found to satisfy the Air Force requirements. I reported to the Minister accordingly after studying the relevant files and said that I would defend the choice, so to say, "before God". The Minister said that it would not be necessary, as he found that it was Mrs Gandhi who first approved the acquisition of the Jaguar on file, and had so informed her. The Jaguar lost its relevance as an election issue.

The LCA studies by the integrated team continued. Early 1981, when I was having lunch with Prof M G K Menon at the India International Center, I got a telephone call from Mr V S Tripathy in the Prime Minister's office, stating that he was calling on behalf of the Prime Minister, who desired that I should succeed Dr Ramanna, who reverted to BARC. I met Mr Tripathy in his office. He said that the PM was keen that I should succeed Dr Ramanna as the SA.
I told him that my interests continued to be in aeronautics and obtaining a measure of self-reliance in this crucial field was the objective for which I strove all my professional life in India.
I explained to him what I had in mind, and that without integration of the R&D institutions and the industry, there was precious little hope of ever achieving self-reliance. I also told him that others might well be able to handle the position of SA, and that at that juncture it was essential that I continue to do what I was doing. I made it clear to him that if I were to be appointed as the SA, my first task would be to create an Aeronautics Commission, serviced by a Department of Aeronautics, along the lines of Space and Atomic Energy Commissions. Mr Tripathy remarked that he also believed in the cause I was striving for, and said that he would help me in achieving that objective.

I then called on Mr Rao Sahib in the PM's office. He too said that he appreciated what I was trying to achieve, and asked me to give him an organization structure to achieve this objective. I gave it to him, and told him that the cause of aeronautics was what
I would like to work for. I told him that I was not looking for a job but for a task, and was deeply committed to obtaining self-reliance in aeronautics. He too said that I should take over as the SA. He then told me to call on Dr Ramanna, who had returned to head BARC. It was a disastrous meeting as far as the cause of establishing an integrated aeronautical base was concerned.
I called on Dr Ramanna on 28th January 1981. I had extended discussions with him. He told me that I would weaken the office of the SA, were I to create the Aeronautics Commission. I then asked him if he was strong

enough as the SA to make sure that the GTRE engine under development then, would be the chosen power plant for the LCA. I told him that I could find a hundred reasons why it would not be suitable, whereas I would have to make certain from the word "go", that the engine and the airframe would be compatible. As it turned out, the gas turbine under development by GTRE then was unfit for use as a possible power plant for the LCA. He said that he understood what I was saying, but I would be weakening the position of the SA, never mind even if it strengthened the cause of aeronautics. As I was leaving his office after lunch, I asked him how strong DAE would be if BARC was not an integral part of it. He understood what I was saying. I told him to find somebody else and that it meant nothing to me to be called the SA. Shortly thereafter, I was asked to meet Mr Shivaraj Patil, Defence Minister. He wanted to know what I was then doing in NAL since he saw me as the Vice-President of CSIR. I explained to him what I was doing. He had known me well. Nevertheless, Dr Ramanna's views prevailed. I was reliably informed that when the minister put up Arunachalam's name for the position of SA, the PM's office returned it to him for re-examination. Apparently, Dr Ramanna advised the minister to send it back to the PM's office. The PM approved the appointment of Dr V S Arunachalam. Dr Arunachalam, a metallurgist by training, earlier in BARC and subsequently an Assistant Director in the Materials Science Division in NAL, and at that time working as the Director of DMRL, succeeded Dr Ramanna.

The feasibility studies of the LCA by the integrated design team were progressing satisfactorily. The time came to conceive of an organization structure to handle the project further. A meeting was called at which the Secretary, Defence Production, Mahesh Sareen, Dr Arunachalam and I were present. It was unanimously agreed that the Aeronautical Development Agency (ADA) should be created to handle the LCA program. It was also unanimously agreed that its responsibility would be to fund, manage and monitor, the LCA program, and that it would be a lean organization, which could be closed at short notice. The idea was that HAL would be the prime contractor, with NAL, ADE, GTRE, and other organizations working in subcontractor mode, under the auspices of ADA.

I was informally being consulted by Vivek Sinha, the then Director of Aeronautics, while he was preparing the agenda paper for the LCA program approval by the Cabinet Committee for Political Affairs (CCPA). Just before submitting it, one day, Dr Arunachalam waved it in front of me and remarked that he would not have the courage to submit it to the Cabinet Committee were it not for the fact that I was behind the program. My response to him was succinct. I told him to go ahead and submit it and that I would be fully involved in the program. As it eventually turned out, he made it impossible for me to continue.

ADA was registered as a society. It was generally agreed that I would be the first Director General of ADA, with the rank of Secretary to the Government of India. But surprisingly, the proposed memorandum and articles of association, and the bye-laws of
ADA were not shown to me before the society was registered. Suspicion in the SA's office took its ugly roots and continued to spread. I was still in NAL, but was managing the LCA program. One of the important decisions I took was to bring back Raj Mahindra, who had spent his entire professional career as an aircraft designer and was primarily responsible for the design, development, type certification, and keeping track of the production of HJT16. I noted that every drawing related to the production of HJT16 carried his signature. I considered him indispensable for the program, because of the wealth of his experience. He was, in fact, the moving spirit behind the feasibility studies of the LCA. I formally took charge as DGADA on July 2nd 1984, having retired from NAL end of June. The first thing that I did was to disclose my full financial status to Mr Rao Sahib, the then Cabinet Secretary.

In May 1985, I got a telephone call from Mr K S Bhatnagar, then Secretary, Defence, who wanted me to accompany him to Paris, as Air Chief Marshal (retd.) Latif, then Ambassador to France, was keen that we should meet the French Defence Minister. In his office, the Ambassador suggested that we should retain Marcel Dassault as our consultants on the LCA program, and inform the French Defence Minister accordingly. The Defence Secretary told him that the procedures for such decisions were very detailed, and that such a commitment could not be given at that stage. I returned to Delhi and formally submitted the LCA feasibility studies immediately to Air Chief Marshal Katre, and requested him to formally issue the ASRs based on the feasibility studies. Earlier, when he was the Chairman of HAL, I got to know him fairly well.
I was a member of the Board of Directors of HAL for over 12 years.

There was a story behind Katre's association with HAL, which eventually had ramifications on the LCA program. There was reliable information that his predecessor, Baljit Kapur, as chairman of HAL, was misusing his authority by giving preferential consideration to a company started by his nephews. This came to the

attention of the then Secretary, Defence Production, Mr Mahesh Sareen, who in turn brought the matter to the attention of the Defence Minister. It was decided by them, that Kapur should go. The Secretary called him to his office during lunchtime, and took his resignation after a brief meeting with Mr Venkatraman, the Defence Minister. The same evening, Mr Sareen took along with him to Bangalore Air Marshal Katre, who was then heading the Western Command. Kapur was relieved of his responsibility, and Katre took over as the Chairman of HAL. Mahindra and I knew Sareen well. Kapur thought that we had something to do with his dismissal. Sareen was a person of high professional integrity, and not swayed by friendships in living up to his administrative responsibilities. Kapur could not touch me. He arranged for questions to be raised in the Parliament stating that Mahindra's loyalties were suspect, as his wife was British. It was as if Rajiv Gandhi would be suspect because his wife was Italian! Mr Venkatraman defended Mahindra, and said we needed more people like him. His successor, Mr Narasimha Rao, also spoke in the same vein. We continued to work in ADA.

Shortly after taking over as the DGADA, in view of the importance of coordinating the development of an appropriate engine for the LCA, I proposed to the SA, Dr Arunachalam, that the monitoring and funding of the development of an engine suitable for the LCA in GTRE should be handled by ADA. He refused. The engine development would then have had a better chance. The engine required as a power plant for the LCA was not even on the drawing board then. Its development started later. As of date (early 2006) it is still under development. It is most unlikely that the Kaveri engine currently being developed by GTRE will be available at least before the first thirty or so of the LCA are manufactured. This is again a classic example of an agency head being really unaware of the implications of his decision.

However, although I was the chief executive of ADA, Arunachalam as the chairman of the Governing Body started taking executive decisions. My position was getting to be untenable.
I told him several times that I would be glad to leave if he wanted to appoint somebody else, that I had no interest other than successfully developing the LCA, and that I would ensure before
I left, that there would be at least two persons for all senior positions for succession, and that I should be left alone to run ADA. It would seem to have fallen on deaf years. The issue reached a critical stage on May 31st 1985, when the Science Advisory Committee to the Cabinet (SACC) was about to adjourn for lunch. Arunachalam came to me and asked me to ease Mahindra out. I did not respond. I felt that no useful purpose would be served by my continuing in the position. That afternoon, Prime Minister Rajiv Gandhi chaired the last formal meeting of the SACC. I drafted my letter of resignation later in the evening. The following morning, I returned to Bangalore and asked Mahindra for his resignation, after informing him of what had transpired. I felt that if I did not command the confidence of the ex-officio chairman of the Governing Body, who had been working under me earlier, and if he felt compelled to interfere with ADA operations at the working level while knowing nothing about aircraft development, I had no business to continue. In the first draft of my letter of resignation I mentioned that I had asked Mahindra for his resignation as desired by the SA, and enclosed Mahindra's resignation letter also. Before sending it,
I showed it to Air Marshal Wollen, the then Chairman of HAL. He suggested that I should omit any mention of Arunachalam asking me to ease Mahindra out. I deleted it accordingly. It was a mistake, and I should have retained the reasons for my resignation. I brought the matter to the attention of a person who was much respected in the administrative circles in Delhi. He too felt that it was the right thing to do. I mailed our resignation letters on 14th June 1985.

Early July, Mr Bhatnagar, Secretary, Defence wanted to be briefed on the progress in the LCA program. I arranged a meeting and told him that neither Mahindra nor I would speak on the occasion, as strength should be at working levels, and only they would make the presentation. He was deeply impressed by the progress made, and suggested that a similar presentation should be made to the Defence Minister. It was arranged for July 20th 1985.

But before the Minister came to Bangalore, Prof M G K Menon desired that Mahindra and I should meet him in Ashoka Hotel. Also present at the meeting were Dr Arunachalam and Vivek Sinha from DRDO. Prof Menon said how important it was that Mahindra and I should continue in ADA. I was taken aback by his comment. I told him that it was never our intention to resign, but that Dr Arunachalam wanted me to ease Mahindra out, and that as a matter of principle, I felt I too should resign, as I did not command the confidence of the SA, who was the ex-officio chairman of the Governing Body of ADA, and that if he questioned my judgment in my sphere of responsibility, I had no business to continue. Arunachalam knew too little about aeronautics to take any sensible decisions, as subsequent events amply proved. Then I got the shock of my life. Dr Arunachalam told Prof Menon that he had never asked me to ease Mahindra out; a blatant lie if ever there was one. I told

Prof Menon that if ever I had any doubt about the wisdom of my decision, it was cleared by this blatant lie. Prof Menon then said that he knew nothing about this. There ended this sordid meeting. I made a serious mistake in deleting the mention of Arunachalam's desire to have Mahindra eased out, in my resignation letter.

On July 20th 1985 Mr Narasimha Rao, the Defence Minister, was briefed by the staff at the working level about the progress made so far. He left afterwards for another meeting and came back at 4 pm to continue discussions. He looked visibly pleased with the progress made till then. He wanted to know what I wanted next. I told him that the Air Staff Target must be converted to Air Staff Requirement to proceed further. He said that it would be done. Air Chief Marshal La Fontaine, who succeeded Katre, said that he fully supported the program. The Finance Secretary sitting next to me said that I should approach him for all the money I wanted. The Minister wanted to know if there was any engine other than the Rolls Royce RB199 that would satisfy the requirements of the LCA. I told him that the older generation GE404 also had the necessary thrust. There were no proposals to up-rate it at that time, while such a study was being made on the RB199. The Minister asked Dr Arunachalam to look into the matter. As it turned out, it would seem that other considerations ultimately decided its choice as a power plant for the LCA. The meeting adjourned, and the Minister wanted me to accompany him to see NAL. As I was leaving, I told Dr Arunachalam that I had done my job, and he should find a successor for me, and that I was not going to continue after what had happened. He then asked Mahindra. He too said the same thing. He then asked me what he should do then. I told him that he should have thought about it when he asked me to ease out Mahindra. He then said he could not quit, as he needed the job. As a matter of fact, from the time my resignation was accepted end of November 1985, till I started getting my US Social Security benefits in early 1988, I had a very difficult time financially, what with a meager pension of less than Rs 4,500 per month from CSIR. But principles were important to me and I could not conceive continuing as DGADA under the circumstances. While accompanying the Minister to NAL, I told him that there were important policy matters, which could be decided only by him, and asked whether I could bring them directly to his attention. He said that he was surprised by my question, as I was the chief executive of ADA, and he was the president of the society of ADA, and that it was well within my rights to bring them directly to his attention. There was a reason for this question. After the first general body meeting of ADA presided over by the Minister, I issued a brief press release, and sent a copy of it to him and to Dr Arunachalam, the SA and ex-officio chairman of the ADA governing body. Arunachalam informed me that the Minister did not desire me to have direct contact with him. I told the Minister in the car that to have a halfway decent chance of self-reliance in aeronautics, there should be formal integration of activities among the R&D institutions and the industry.

In August 1985 I got a call from the Minister's secretary, Mr Ramu Damodaran, an IFS officer, saying that the Minister wanted to see us. Mahindra and I had an extended meeting with him on a Sunday morning in his office. The Minister remarked that he was not talking to me as the DGADA but as a scientist, and would like to have an honest assessment of our ability to build the LCA. I told him that I would speak to him as a scientist. I told him that while we were capable of designing the LCA, we needed some critical technologies that were essential to build it. These were composite technology to build parts of the airframe, a thorough understanding of relaxed static stability, and ability to build fly-by-wire control systems. I told him further that following the delineation of responsibilities among NAL, ADE and GTRE, NAL had acquired enough capability to handle the composite structures in the LCA without any problem. As it turned out, we did not have an autoclave big enough to make the CFC wing skins, and we had to import them. Subsequently, NAL supplied on contract the autoclave to HAL. I told the Minister that in its assigned area of responsibility for FBW systems ADE did not seem to have made any progress, and that we would have to import the technology. I drew his attention to how NAL placed its staff to work with a foreign company while designing the 4 ft trisonic tunnel, and suggested that we should use a similar approach for the FBW systems needed for building the LCA. He was satisfied with my clarifications. I reiterated to the Minister that GTRE would not be able to supply a suitable engine in the near future, and that at least for the first thirty aircraft or so, we would be compelled to use a foreign engine, and the Rolls Royce RB199 was a strong contender. There were proposals for increasing its thrust further. As mentioned already, GE404 was chosen as the power plant. He wanted us to meet him again at his home that afternoon on our way to the airport. The Minister stated that he understood what needed to be done and would see us again in September when I would be in Delhi for the Governing Body meeting. He wanted me to prepare a note on restructuring aeronautics and bring it along. When the meeting of the Governing Body was taking place end of September, I got a message that the Minister would not see me later that day, but only the following morning. The following morning, I got a telephone call from the Secretary, Defence Production, Mahesh Sareen, saying that Mr Narasimha Rao was no longer our Minister, and Arun Singh had taken over. I sent him a copy of the structure for reorganizing aeronautics as an integrated activity in the country as desired by his predecessor, and requested him to relieve us at an early date. We were relieved end of November 1985. Shortly thereafter, I wrote a letter to Mr Rao Sahib, who had by then retired and become a Director in the World Bank, explaining the circumstances under which I felt compelled to resign. He took interest in trying to get me

to join as the SA. He was made fully aware of Raj Mahindra's capabilities as a designer.

At the first general body meeting presided over by Mr P V Narasimha Rao as the Defence Minister, Mr V P Singh, the Finance Minister, wanted to know the cost details of the LCA program. My colleagues told me not to give any actual figures, but give only rough estimates. I told them that I would not do such a thing, as it would compromise my credibility and integrity. I told the Minister, that we made the cost estimates based on the costs in HAL at that time, and provided for inflation within the country and abroad. We estimated that the first prototype would fly in about eight years, in 1991, and that we would require six prototypes to complete the flight tests in about three years, and hopefully start production around 1994. I informed the Minister that the estimated cost was Rs 1250 crores (Rs 12.5 billion), and that every year of delay would cost another Rs 150 crores (Rs 1.5 billion). He looked satisfied, and left immediately after the clarification. Apparently, instead of six prototypes for flights, only two were approved. This would inevitably increase the time for the flight tests alone to about nine years, apart from any other reasons for delay. As it turned out, the first prototype flew ten years later in January 2001, and the reported cost by then was Rs 2750 (Rs 27.5 billion), not too far from the estimate given to the Finance Minister.

The ASRs stipulate some important parameters to be achieved by the LCA before the Air Force can accept the aircraft and order series production. If there are any shortfalls, these have to be negotiated by the ADA with the Air Force. The critical parameters are: time for level acceleration from 0.8 Mach number to 1.2 Mach number, rate of turn, rate of climb, range, and war load. If there is a shortfall in any of these parameters, it would amount to deterioration in the stipulated performance and compromise the fighting capability of the aircraft. Typically, about 2500 flight tests would be needed to establish these parameters. Apparently as of date, about 500 flight tests have taken place. It is clear that the LCA has a long way to go before it can be considered acceptable to the Air Force without any compromise in the original ASRs and without any concessions. If newspaper reports are true, the Air Force has apparently placed an order on HAL to supply 40 LCA of which 20 were firm orders, with series production booked for eight aircraft (Vijay Times 10/1/06).

This is a significant development. Nothing would give me greater pleasure than to see the LCA fully living up to the expectations of the Air Force, and becoming the backbone of our fleet for air defence. One would hope that ADA will fully satisfy the ASRs, with such minor concessions as the Air Force may agree to, so that the LCA will not meet the same fate as the HF24. It is essential that the LCA fully satisfies the ASRs, even if it was too late to really respond to the Air Force's needs, if only to know how to design such aircraft, without repeating such mistakes again. In this connection, I recall a visit to the Air Force museum at Wright Patterson Air Force Base in Dayton, Ohio. What struck me was the number of aircraft that were built, but did not go into production. Each one of them had added something to the pool of knowledge about how to design aircraft.

The design of gas turbines is more complex. It depends on enormous test data generated by the engine manufacturers. As a Pratt and Whitney designer told me, engine designers tend to be a mafia, and keep their knowledge close to their hearts. Prof Howard Emmons from Harvard University, a member of President Reagan's committee to examine whether the US should go in for the development of a supersonic passenger aircraft, confirmed this during his visit to NAL, and highlighted the importance of extensive testing in the development of advanced-technology gas turbines. It may well be necessary for GTRE to enter into an agreement for the successful development of the Kaveri engine, the proposed power plant for the LCA. GTRE would learn much from such collaboration. I think it was a serious error of judgment in not retaining AVM Roy Choudhuri. I greatly admired Dr Krishnan, who became the Director of GTRE some time later. But he was a metallurgist, and did not have any knowledge in gas turbine design. It is too expensive to try to learn on the job in such projects. I think Dr Kota Harinarayana did a commendable job, considering the heavy odds against which he had to function as the LCA Program Director. He had to learn a lot on the job, with inevitable delays, but he did succeed in making the LCA fly. He should have been made the DGADA. It was a pity that his contributions were not sufficiently appreciated by the SA's office.

I believe the lesson to be learned from the history of aeronautics in India is that it is essential to restructure aeronautics so that we do not repeat the same mistakes. All the R&D laboratories primarily concerned with aeronautics, such as NAL, ADE, GTRE, and the HAL Design Bureau as well as its corporate R&D base, have to be brought under the authority of the Director General of the Aeronautical Development Agency. It will have to be headed by a person who has a good understanding of R&D and the design of aircraft, and a flair for administration. It is the *relevant* scientific and technical knowledge and experience that will make or break an institution in fields of high science and high technology, such as aeronautics, and not *any* knowledge and *any*

experience. It is not surprising that in the technologically successful institutions like Space and Atomic Energy, people who have the potential are groomed within the organization to occupy senior positions of responsibility, including the position of the agency Head. It was the lack of such experienced people in senior management positions that caused the enormous problems in the development of the LCA and aeronautics in general, in the past.

The Governing Body of ADA should have among others the SA, the Secretary, Defence Production, MD of the HAL Design Bureau, the Deputy Chief of Air Staff, the Director General, Aircraft Production Agency, and the Member, Finance in the proposed Aeronautics Commission. If any aircraft are to be built under license, ADA shall be the primary agency to absorb the imported technologies to build thereon, to make the country less and less dependent on licensed production. It would be an unfortunate error of judgment to keep the Air Force out of any committees in ADA concerned with the development of the LCA. I hope the information that was given to me was not true.

The Director General, Aircraft Production Agency (APA) should be a serving Air Marshal who has earlier headed the Maintenance Command, as the Air Force would be the primary customer for any aircraft designed and developed, or produced under license. The APA Governing Body should include, among others, DGADA, the SA, the Secretary, Defence Production, MD Production, HAL, the Deputy Chief of Air Staff, and Member, Finance of the Aeronautics Commission.

The Aeronautics Commission should be headed by a professional who has a good understanding of the various aspects of research, design, development, and manufacture of aircraft, preferably groomed within the organization. He shall also head the Department of Aeronautics, much along the lines of the Space Commission. Like Space and Atomic Energy, the Commission shall have not less than four and not more than seven members, including the Member, Finance. The Commission shall report to the Defence Minister.

Perhaps a simpler procedure would be to upgrade the present Aeronautical Development Agency (ADA) to that of a Commission, responsible also for research, design, development, and manufacture of aircraft, with the appropriate supporting organizational structure reporting to it. Without such restructuring of the aircraft industry and the associated bodies, it would be impossible to obtain a measure of self-reliance in the aircraft industry. This is essential for a country of our size and with its avowed independent foreign policy.

Mistakes and errors of judgment

Looking back over the years of my professional life, if I ask myself could my decisions have been any different, my answer would be NO. I perhaps made a mistake in being so transparent about my desire to restructure aeronautics. Perhaps I should not have disclosed my views on the need for restructuring aeronautics, when I was invited to succeed Dr Ramanna as the SA. Since he was from DAE, which was integrated similarly, I thought I would get his support. I was confident of getting the support of the PM's office, and from Mr Shivaraj Patil, the then Defence Minister, had Dr Ramanna agreed to my suggestion. He did not want to have his (concurrent) authority as the SA compromised, never mind that he knew little about aeronautics, as he himself admitted, when both of us were asked by the then Defence Minister to look into the issue of the acquisition of the Jaguar fighter aircraft, when it was becoming an election issue. I found that the bureaucrats, who are not familiar with issues, desire unanimity among the professionals whose advice they seek, before they take decisions. But transparency is a trait I suffer from, and sometimes it even led me to make tactless comments and decisions, which I later regretted. Clearly, I made a mistake in expressing my views to Dr Ramanna, thinking that he would appreciate my arguments and agree to the restructuring of aeronautical activities in India along the lines of DAE. It was ironical that he did not agree, since it was precisely in such an integrated environment in Atomic Energy under Bhabha, that he grew. I have to regretfully conclude that he was no Bhabha in his vision for administration of highly specialized S&T institutions. I had no regrets for rejecting twice the offer of DGSIR, as my heart was not in it. Restructuring aeronautics was close to my heart. It was for this purpose that I returned home. Restructuring this field is essential if we wish to have a measure of control over our destinies in times of war.