Report of the Director

A quick round-up of the major highlights and R&D events in 1998-99

It gives me great pleasure to present the annual report for the year 1998-99.

Highlights

On 20 June 1999 the Cabinet Committee on Economic Affairs (CCEA) formally cleared the NAL-led project to design and develop the SARAS multirole light transport aircraft. This approval meant that after many years of uncertainty the SARAS project was well and truly on! The project, expected to cost Rs 131.4 crores, will be jointly funded by the Technology Development Board (TDB), CSIR, Ministry of Civil Aviation and HAL. I have asked the NAL teams to work towards a September 2000 deadline for the first SARAS flight. This constitutes a very stiff deadline but I feel confident that the combined effort of teams from HAL, TAAL, KIPL, ASTE, CMERI, SERC, GTTC and others working together will impart the project a unique synergy.

After the successful first flight of the second prototype of HANSA-3 on 11 May 1998, a day which was later declared as the National Technology Day, I threw a challenge to the HANSA teams to build the pre-production version of the HANSA aircraft in exactly a year. I was delighted when my colleagues successfully met this challenge and the new VT-HNS HANSA aircraft took to the skies on 14 May 1999. Earlier the second HANSA-3 prototype (VT-XBL) successfully participated in the flying displays at Aero India '98, the third Bangalore air show (in what must be a unique record, three different HANSA versions have successfully flown at the three air shows organised in Bangalore so far). In October 1998, NAL conducted a two-day workshop to expose pilots and flight instructors to the HANSA aircraft. The workshop proved to be very successful, both in introducing pilots to the new trainer and in obtaining their feedback. The HANSA-3 also went through a series of flying tests in Pondicherry early in 1999 and it is expected that HANSA will receive the JAR-VLA type certification from DGCA at any time now. Another highlight in 1998-99 was the success achieved by teams from the Advanced Composites Unit in helping Vikram Sarabhai Space Centre (VSSC) to revamp, reinstall and computerise its vertical Reaves autoclave. I was especially delighted that our teams completed the task well within the stipulated schedule.

I am also happy to report that NAL's campus-wide network connecting over 300 computers, is now operational. The project to network the Laboratories was completed in two phases. In the

The HANSA-3 (VT-XBL) flying over Pondicherry

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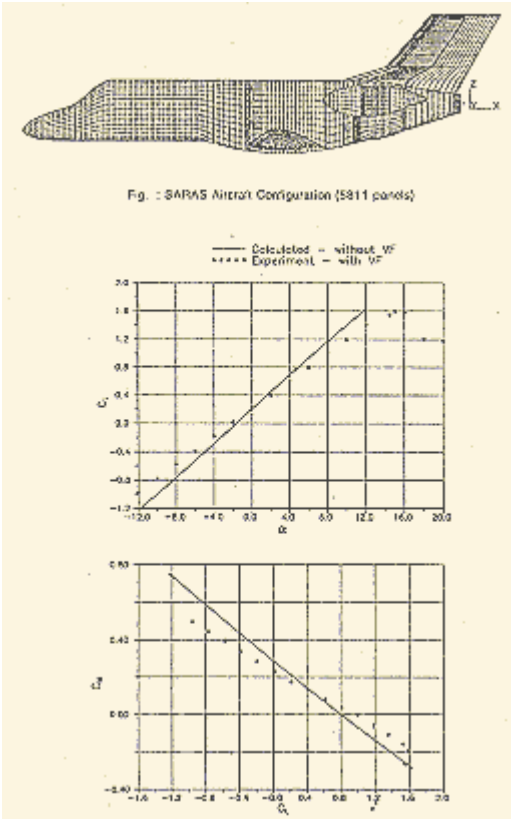


Panel code calculations on SARAS lift and moment coefficients

Scientists at CTFD Division are carrying out a

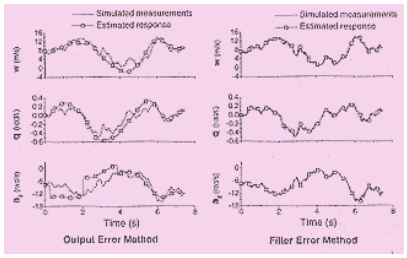
first phase connectivity was achieved within the Kodihalli and Belur campuses. The second phase involved the establishment of high speed connectivity between the Kodihalli and Belur campuses situated 5.5 km apart. The objectives of the NAL network are three-fold: desktop access to supercomputing facilities, Internet connectivity and the development of Web-based management information systems.

In the Divisions The *Advanced Composites Unit* worked extensively to support the design and development effort related to the LCA and SARAS projects. For the LCA the Unit completed the task of fabrication, certification and supply of all the CFC spars, fairing blocks and fairing skin. Some LCA centre fuselage components have also been fabricated and sent for testing. The LCA fin and rudder assembly is undergoing lightning tests. In another programme, which appears very promising, the Unit is developing a smart control surface using shape memory alloys. The Unit has also done some useful work in repairing damaged IAF aircraft components. The *Aerospace Electronics and Systems Division* is getting deeply involved with projects related to avionics and electrical systems for the SARAS; its work, along with FMCD, to develop an autopilot for SARAS is progressing well. Teams are also seriously involved with the 4m x 8m HAL autoclave project, projects in active noise control, and in offering DFDR readout services and systems; the Division recently handed over its decoding system for the BUR-1 DFDR fitted on MI-172 helicopters to MESCO Airlines. The new network analyser for material characterisation will give a good fillip to activity in the Division's Computational Electromagnetics Lab. The Acoustic Test Facility continues its excellent support to the country's space programme. I have already mentioned the CCEA's clearance of the SARAS project and the successful first flight of the pre-production HANSA (VT-HNS) aircraft. Other activities at the *Centre for Civil Aircraft Design and Development* include a long round of wind tunnel testing on the SARAS to generate aerodynamic data particularly at high Mach and Reynolds numbers. The CATIA software at the Raj Mahindra CAD Facility continues to be extensively used, chiefly to generate models of NC machined components. I have also been reassured that the Facility is not likely to face any Y2K-related problems. The *Computational and Theoretical Fluid Dynamics Division* is now looking to handle fluid flows over more complex geometries using higher order flow models such as the Euler and Reynolds-averaged Navier-Stokes (RANS) models. The Division is doing valuable work for its sponsors, notably Naval Science and Technology Laboratory (NSTL) and Defence Research and Development Laboratory (DRDL) and, increasingly, reorienting itself to support the SARAS project. Several computations are being carried out to obtain aerodynamic refinements to the SARAS configuration. The *Experimental Aerodynamics Division* continues to do interesting work in the area of drag reduction and laminarization, flow diagnostics and aerodynamic data generation. A particularly noteworthy application was the study undertaken by the Division to see how drag reduction strategies could be implemented on state transport buses to effect fuel savings. The Division has also initiated work on pressure sensitive paint techniques. The project to study the relaminarisation of swept wings for Boeing is

series of computations to obtain aerodynamic refinements to the SARAS configuration

1:10 scale drag model mounted in the 1.5 m low speed wind tunnel

Experimental Aerodynamics Division continues to do interesting work in the area of drag reduction and laminarization



Output error method vs filter error method

The Flight Mechanics and Control Division is looking at two different parameter estimation techniques for LCA flight data analysis

A lab for testing Wankel rotary engines and structural ceramic components has been established

The Wankel engine has a great potential for application in both unmanned and manned light aircraft and we expect the new laboratory to promote several interesting investigations

going on well. The *Flight Experiments Division* continues to play a vital role in the HANSA programme, especially in flight testing and aircraft maintenance. The HANSA-3 (VT-XBL), maintained by the Division, has now logged over 130 hours of incident-free flying. Some natural laminar flow experiments are also being undertaken using HANSA-2 RE. In the *Flight Mechanics and Control Division* the LCA TD-1 first flight standard control law flight clearance documents are in the final stages of completion, bringing the curtain down on what has truly been a remarkable milestone in LCA control law development. The Division's engineer-in-the-loop (ELS) simulator continues to provide the benchmark for other simulator platforms. In the area of system identification, the Division is exploring two aircraft parameter estimation techniques: stabilised output error method and filter error method for LCA flight data analysis. The Division is also deeply involved in SARAS autopilot design and testing. After its success in re-engineering the GCM weather prediction code, the *Flosolver Unit* has now shifted its sights on the design and fabrication of a communication switch for parallel supercomputers. The proposed NAL switch will incorporate a 'scale-invariant' algorithm, which will pave the way for the design and development of a high speed 32-processor parallel computer with linear scalability. The *FRP Pilot Plant* is largely pre-occupied with the HANSA fabrication and the development of a radome for ISRO's Doppler weather radar. It continues its involvement in the fabrication of carbon composite air intake models chiefly for the LCA. The *Materials Science Division* continued to undertake its wide spectrum of activity: the failure analysis and accident investigation group undertook 54 investigations in 1998-99 for organisations which included GTRE, HAL and the Indian Navy. As a part of the effort to develop precision instruments for measuring physical properties of materials, the Division developed an a.c calorimeter for studying the specific heats of metallic samples up to 1000 deg C and 30 Kbar pressure. The technology for the development of thermoset prepregs is now being transferred to IPCL, Vadodara. The AVRA Mk 2 system is being further improved with better hardware and user-friendly software; successful field trials on the AVRA were conducted on a ship in Goa in August 1998. Thermal shock and thermal fatigue studies of ceramic materials undertaken at the Division point to a technique where cracks can be detected much earlier than the conventional quench tests. The *National Trisonic Aerodynamic Facilities* conducted only 819 blowdowns in the 1.2m wind tunnel during 1998-89 (down from 1148 blowdowns in 1997-98) because there was a, long-pending, facility shutdown to improve the unsteady flow quality in the tunnel. The refurbishment programme included the extension of the existing settling chamber by introducing a larger new duct in place of the two smaller spacer ducts. Suitably designed acoustic baffles were installed in the new duct and wind tunnel tests conducted after the refurbishment indicated that the acoustic baffles reduced the total pressure fluctuations in the settling chamber by a factor of about 5 to 6. The 1.2m tunnel continued to support all major national aerospace programmes being undertaken by ADA, ISRO and DRDO and was also used for SARAS tests, It was also heartening to note that the 0.6m transonic tunnel was used much more extensively during 1998-99. A laboratory for testing Wankel rotary engines

Structural testing of HANSA-3 II

The Structural Integrity Division played a major role in the HANSA testing and certification effort

Experiments at Maitri station

NAL's Wind Energy Group is undertaking some novel wind power experiments in Antarctica

Dr B R Ambedkar birthday celebrations

The Sixth Dr B R Ambedkar Lecture was delivered by Mr S Swatantra Rao

Visit of Parliamentary Committee

The Parliamentary Committee on Science & Technology led by Mr S R Bommai

and structural ceramic components was recently established in the *Propulsion Division*. The Wankel engine has a great potential for application in both unmanned and manned light aircraft and we expect the new laboratory to promote several interesting investigations. Other activities in the Division include the design, fabrication and testing of a high pressure ratio axial fan stage (in collaboration with the Chinese Aeronautical Establishment and the Beijing University of Aeronautics and Astronautics) and experimental investigations on the effect of a casing treatment on the performance of an axial flow transonic compressor stage. The Division continued its project, sponsored by United Technologies, USA, to test high Mach number cooled gas turbine blade profiles in the transonic cascade tunnel. One of the major achievements of the *Structural Integrity Division* was its support for the mechanical properties characterisation and structural certification testing of the HANSA-3 prototype 2 aircraft. Elaborate exercises involving feature level tests, design and fabrication of customised rigs etc. were involved in this remarkable effort. The Division continues to carry out a large number of contract projects for ADA, DRDO, IAF and others. The Boeing contract for lug damage tolerance studies was completed this year; LCA-related lug joint testing under spectrum loading is on. Other projects undertaken this year include fatigue and life extension studies for KA-28, and Mi-17 helicopters and vibration and shock testing for various non-aerospace organisations including Indian Railways. The *Structures Division* is re-orienting itself in a big way to support the HANSA and SARAS civil aircraft projects. The Division played an important role in the design exercise leading to a substantial weight reduction in HANSA-3. Another interesting exercise involved nonlinear structural analysis of SARAS control surfaces. Other important projects undertaken in 1998-99 include the design, structural analysis and flat pattern drawing generation of aerostats with different configurations, nozzle buffet response studies for the GSLV, integration and installation of the HAL autoclave and the design of several scaled LCA Kaveri air intake models. The major aerospace contributions of the *Surface Engineering Unit* include sunshield panels for the passive radiative cooler of the VHRR of INSAT 2E, development of surface modifications for the slat track, a component of the LCA landing gear, and the initiation of work on the development of pressure sensitive paints. The contributions to the energy sector include the project to improve the solar to electricity conversion efficiency of silicon photo voltaic cells. Finally, the *Wind Energy Programme* continues its successful experiments on wind power applications in Antarctica. This year specially developed charge controllers were tested and used with wind powered battery chargers at the Indian Maitri station. Other exercises undertaken by the Group include detailed power curve measurements on large grid-connected wind energy converters and the discovery of a possible windy site at Jaintia Hills in Assam. **Technical Services** The *Computer Support & Services Division* was involved in the establishment of the campus-wide network in association with a team led by Dr S Sridhara Murthy. The e-mail server set up by the Division was used extensively and went a long way in promoting the e-mail culture at NAL. The training programme on "Computers and

visited NAL in August 1998

CSIR Foundation Day Celebrations

Dr N Seshagiri delivered the CSIR Foundation Day Lecture

Networks" for NAL colleagues, organised by the Division, is also doing very well. The *Engineering Services Division* was, for most of the year, pre-occupied with the HANSA, SARAS and LCA aircraft projects. The Division is also playing a major role in the development of mechanical and electrical systems for the HAL 4m x 8m autoclave project. The *Estates and Building Unit* continued to be busy: the Unit's major accomplishment in 1998 includes the construction of a new aircraft hangar on the Belur campus. The *Information Centre for Aerospace Science and Technology* (ICAST) also had an event-filled year. Their project to create an online database of books, reports and journal back volumes is progressing well. ICAST's Web site, AeroInfo, is already a remarkable online source for aerospace links on the Internet. The *Information Services & Systems Section* is expanding its sphere of activity in a big way with new projects in Web-based management information systems and multimedia. The NAL Web site, managed by this Section, is also doing well. The Section played major supportive roles in IT.com'98, organised by the Government of Karnataka, and Aero India '98. The organisation of Web'99, a meeting of CSIR's IT persons, was also a novel idea. The NAL *Museum* was formally inaugurated by Prof R Narasimha on 11 May 1999 (National Technology Day) and fulfils a long-felt need to showcase NAL's R&D capability. The *Project Monitoring and Evaluation Section* did a fine job in achieving an external cash flow which was even better than last year. The Section also supports me in a variety of other ways: by being the focal point of all R&D management meetings and in CSIR's customer evaluation programme. The *Technical Secretariat* is being re-oriented to play a bigger role in IPR-related issues; it continues to provide good support in public relations, guest house management, international S&T collaboration and in managing NAL's very popular training programmes. The project to obtain the ISO 9001 certification, which is managed by NALTech, is making steady progress. In my next report I hope to be able to announce that NAL is an ISO 9001 organisation. **Other Events** The twelfth NAL Foundation Day Lecture on *Aviation Safety* was delivered by Mr H S Khola, Director-General of Civil Aviation on 14 August 1998. Mr Khola's thoughtful lecture, replete with statistics, explained how DGCA's new safety practices have brought down accident rates to a third of the levels existing a decade ago. The Second NAL Technology Lecture, delivered the same today, was a splendid narrative by Dr S Srinathkumar on Control Law Design and Validation for a Combat Aircraft. The highlight of the CSIR Foundation Day function, on 26 September 1998, was Dr N Seshagiri's illuminating lecture on the *Implications of the Recommendations of the National Task Force on IT to S&T Organisations*. Himself a member of the Task Force, Dr Seshagiri's talk offered us a glimpse of how IT will change the way we do research and build technologies. The function also featured the engrossing NAL Business Lecture by Dr RMVGK Rao. The 1999 Science Day Lecture was delivered by Prof N Kumar, Director, RRI on *Deterministic Chaos* while the Sixth Dr B R Ambedkar Lecture was delivered by Mr S Swatantra Rao, Principal Secretary, Government of Karnataka on *Dr B R Ambedkar's Thoughts - Their Relevance to the Past and the Present*. This year's Hindi Day Lecture was delivered by Dr R N

Singh, Scientist-in-Charge, C-MMACS who spoke on *Origin of the Himalayas*. I was also delighted to note that two more courses were offered this year under the NAL-UNI Lecture Series; I consider this lecture series to be an excellent idea and we must do everything possible to keep it going. The S&T Parliamentary Committee on Science & Technology, Environment and Forests, led by Mr S R Bommai, visited NAL on 17 August 1998. The Official Language Parliamentary Committee also visited us on 6 January 1999. In addition, NAL hosted its usual number of international and national meetings: the National Seminar on Life Extension Strategies for Ageing Aircraft on 27-28 May 1998, the International Workshop on Surface Engineering and Coatings on 25-30 June 1998, the International Workshop on Fibre-Reinforced Plastics on 15-17 September 1998 and the Third Asian Fluid Dynamics Conference on 7-11 December 1998. **Statistical Summary** The NAL staff strength as on 31 July 1999 was 1256. This includes 493 scientists (Group IV: 336, Group III: 157), 539 technical staff and 224 administrative staff. 66 new sponsored projects (value: Rs 940 lakhs) and 15 new grant-in-aid (value: Rs 128 lakhs) were taken up during 1998-99. Our external cash flow this year was Rs 3141 lakhs; about 60% came from ADA (32.6% for the CFC Wing project and 27.4% for other LCA-related projects). In spite of a gradual drop in the ADA component, NAL's external earnings have not fallen; in fact, they increased from Rs 3041 lakhs in 1997-98 to Rs 3141 lakhs this year. NAL actually spent Rs 3769 lakhs during 1998-99 on inhouse programmes (up 13.9% from the previous year), of which salaries accounted for 53.8%. As much as 18.1% of the expenses were towards consumables. The fraction available for capital expenditure was a mere 4.2% although this was bolstered by an additional 9.6% which came through CSIR's funding for modernisation. These figures however continue to be a cause for concern and we must find ways to correct this shortcoming. **Honours** It is always a pleasure to mention the distinctions won by my NAL colleagues: Dr Gangan Prathap was elected Fellow of the Indian National Science Academy, Mr Shyam Chetty received the C V Raman Young Scientist Award for 1998, Dr P K Panda won the Young Engineer Award of the Indian National Academy of Engineering for 1998 and Dr P R Viswanath was invited to deliver an invited lecture at the 30th AIAA Fluid Dynamics Conference. I congratulate all of them for their excellent contributions to aerospace science and technology. Dr T S Prahlad, *Director*