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REPORT OF THE DIRECTOR

It gives me great pleasure to present the annual report for the year 1999-2000.

HIGHLIGHTS

On 1 February 2000 the HANSA-3 all-composite aircraft, with lightning protection and night flying capability, formally received its type certificate from the Director General of Civil Aviation under the JAR-VLA category (*Figure 1*). It was a particularly proud moment for NAL because it marked the culmination of almost a decade-long effort to design, develop and certify India's first all-composite two-seater aircraft (*Box 1*). The certification itself came after extensive flight tests, generation of the necessary compli–ance documents and the introduction of night flying instruments.

The focus of activity has now shifted to the more ambitious SARAS aircraft programme. Work is now in full swing to manufacture the first prototype of the 10-14-seat multi-role light transport aircraft following the approval of the SARAS programme by the Government in June 1999 and the release of the first instalment of funds by the Technology Development Board (TDB) in August 1999. Major SARAS-related activities are now under way at NAL, HAL (Bangalore, Nasik, Lucknow and Kanpur), TAAL and other work centres involving over 600 engineers, designers and contractors. We are extremely hopeful that SARAS will have its first flight very soon.

NAL's Technology Day (11 May 2000) offering this year was the high-speed 32-processor Flosolver Mk 5 parallel computer. A highlight of the Mk 5 design is the development of an "intelligent" high-speed switch; with this switch we expect a dramatic improvement in parallel processing performance especially for the more difficult numerical problems such as weather prediction. I am also happy to note that Flosolver is now being more widely used following the establishment of NAL's campus-wide network. I would like Flosolver to become the preferred high-speed computing platform both at NAL and within CSIR.

IN THE DIVISIONS

The *Advanced Composites Unit* was involved in major design and development projects related to the

⇩ *Figure 1 NAL received the HANSA-3 type certificate from Mr H S Khola, Director-General, Civil Aviation, at a special function held at the S R Valluri Auditorium on 16 February 2000. Dr C G Krishnadas Nair, Chairman, HAL and Air Marshal P Rajkumar, AVSM, VM were also present on the occasion.*

1. Type-certification of the HANSA aircraft / *Dr S S Desai*

NAL's HANSA-3 all-composite aircraft received its type certificate from the Director General of Civil Aviation (DGCA) under the JAR-VLA category. The certificate was formally issued on 1 February 2000.

There was some delay in obtaining the certificate because the DGCA asked NAL to meet the requirements for night flying, but the wait has been worth it: the night flying capability and the lightning protection feature make HANSA an even more attractive trainer aircraft.

HANSA's type certification was a fitting climax to what has been a remarkable aeronautical adventure at NAL over the past decade. The story began with HANSA-2, an experimental version which first flew in 1993. Then came the first of the two HANSA-3 prototypes: the overweight VT-XAL (1996), followed by the lighter VT-XBL (1998) and finally the VT-HNS which first flew in May 1999. With each prototype NAL inched closer to the all-important JAR-VLA certification; the weight reduction exercise carried out for VT-XBL was perhaps the crowning moment of this amazing adventure.

For NAL teams, not quite familiar with the rigours of quality testing and documentation, the certification exercise was a valuable lesson. Working as a single team across R&D Divisions, and utilizing specialist expertise through consultants, advisers and control design engineers, NAL achieved a very significant aeronautical triumph.

LCA and SARAS programmes. The fabrication, certification and supply of all the CFC spars, fairing blocks, fairing skins and landing gear doors for the LCA TD1 and TD2 aircraft has been completed. Work on additional CFC components for the PV1 aircraft is also progressing well, and as per the plans. In an innovative initiative the Unit has designed and developed a composite torque shaft for the LCA rudder to replace the titanium torque shaft (*Box 2*). The Unit also made a notable contribution by offering an indigenous substitute to the ABD 2000 radome, fitted on Mirage aircraft, since the original (imported) radomes were getting frequently damaged.

The *Aerospace Electronics and Systems Division* worked extensively on SARAS development especially in the areas of avionics, autopilot co-development, electrical system design, flight test instrumentation and the development of special test rigs. The SARAS avionics test rig (*Figure 2*) is now ready. This rig will allow us to confirm that individual sub-systems, to be procured from 6-7 different vendors, will work well together under different ground and flying conditions. In the area of active noise control (ANC), the Division achieved improved results for a typical duct using the feed-forward active noise cancellation technique. A number of experiments were conducted both in the duct and the SARAS cockpit mockup; encouraged by the test results, it is now considered feasible to install a practical ANC system on the SARAS aircraft.

Following the successful type certification of the HANSA aircraft, the *Centre for Civil Aircraft Design and Development* is now extremely busy with SARAS activity. MoU's have been signed with nearly 30 small and medium-sized industries to carry out machining work for the aircraft, and work is progressing well at all these centres. The assembly (*Figure 3*) of the major modules – horizontal and vertical tail, and forward, centre and rear fuselage sections — is being carried out at TAAL. Two horizontal tail units have already been assembled and one of them is

⇨ *Figure 2 The engineering test station of the SARAS avionics rig. The rig is currently partici–pating in a rigorous test campaign.*

2. Composite Torque Shaft / *M Subba Rao*

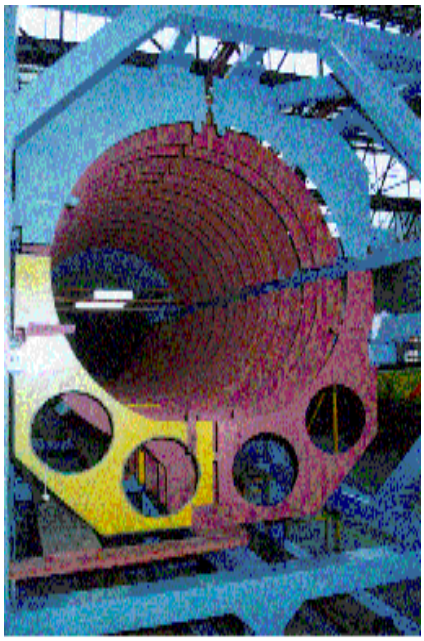
The torque shaft of the LCA rudder is a very complex part that was originally made out of a titanium alloy. The fabrication process included NC machining and electronic beam (EB) welding. Machining was a tough and slow process because titanium is a hard material. EB welding of these parts was also a slow process involving multistage inspection. All these factors made fabrication very expensive, increased the cycle time and required very special facilities.

There was therefore a compelling need to find a cheaper and better alternative, with shorter cycle time and without requiring any expen–

sive special facilities. After a careful study it was decided to replace this torque shaft with a composite torque shaft (see photo). This is a multi-cellular construction with cells present in all the three directions around a non-circular tube. The tube itself is not axi-symmetric. Conceiving a fabrication technique for such as part is not an easy task. The fabrication procedure consists of multi-angular filament winding, lay-up on a flexible rudder bag and on rigid mandrel etc. All these have to be assembled in a highly complex mould in a green stage and cured by inserting in an intricately made vacuum bag. NAL has now made the torque shaft and proved its static and fatigue strength capability.

currently undergoing structural tests. The vertical tail assembly is also at an advanced stage. Wing assembly work, to be undertaken at HAL, Nasik, will commence shortly.

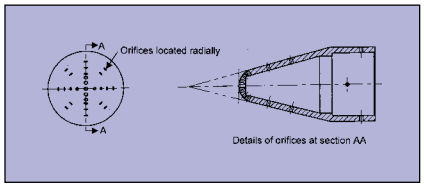
⇩ *Figure 3 The centre fuselage assembly jig of the SARAS aircraft.*



The focus of attention at the *Computational and Theoretical Fluid Dynamics Division* continues to be the application of CFD tools for simulation of flow around complex configurations. The Division is studying the flow around aerostat configurations for ADRDE using a general-purpose panel code; computations have been completed under different flow conditions for two different hull shapes with fins. In another project for DRDL the Division is computing hypersonic flow past a complex re-entry payload configuration using its multi-block upwind RANS solver MB-EURANIUM.

In addition to its work in flow structure, flow management and flow diagnostics, the *Experimental Aerodynamics Division* spent a fair part of its time on aerodynamic testing and data generation for national projects. A major thrust in the Division is in the area of advanced flow diagnostics and applications to complex flow problems; in particular, options offered by laser Doppler velocimetry (LDV), which are non-intrusive and detect flow reversals, are being considered. Phase-averaged two-component LDV measurements, based on a time-series approach, were successfully carried out in the near-wake of a 2D circular cylinder on a sub-critical Reynolds number. The Division also developed a software package for the calculation of flight parameters for use in a flush air data system (*Figure 4*). International collabora–tions with Boeing, USA and DLR, Germany continued. Work on Phase IV of the Boeing contract on relaminarization of swept wings was completed. Wind tunnel studies on drag reduction of KSRTC bus configurations have also yielded very interesting results in terms of fuel savings (*Figure 5*).

The *Flight Mechanics and Control Division* continues to be intimately involved with the design and development activities relating to the LCA control law. The LCA TD-1 first flight standard control law has been delivered and now awaits only the formal certification by the



⇧ *Figure 4 The Experimental Aerodynamics Division has developed a software package for the calculation of flight parameters for use in a flush air data system. The figure shows the schematic of a typical flush air data probe.*

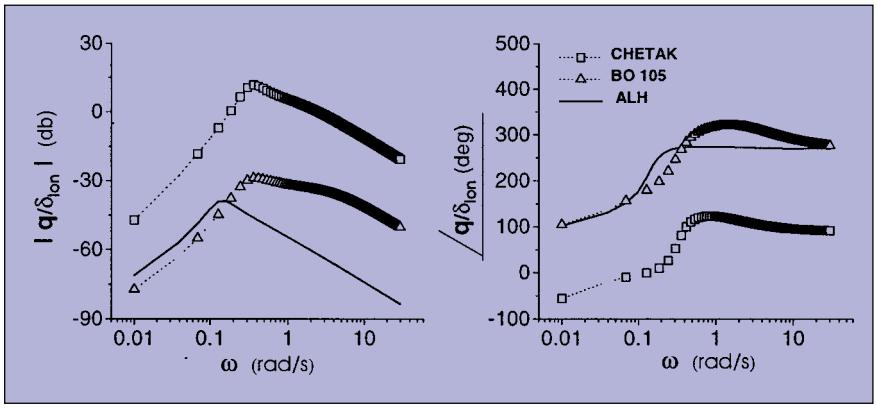
airworthiness authorities for flight-testing. The Division also successfully completed the multi sensor data fusion project for the Interim Test Range (ITR), Chandipur. NAL's project has now been implemented and validated at ITR using real-time trajectories in the playback mode. The project to obtain flight identified aerodynamic stability and control derivatives of the Advanced Light Helicopter (ALH) is also progressing well (*Figure 6*). The Division is also doing some very interesting work on high angle-of-attack flight dynamics of a fighter aircraft (*Box 3*).

I have already talked about the pioneering effort at the *Flosolver Unit* to design and develop the 32-processor Flosolver Mk 5 (*Box 4*). Other initiatives at the Unit include a scientific study of the fluid dynamics of cyclones and the further 'fine-tuning' of the global circulation model (GCM) code for weather prediction.

The *FRP Pilot Plant* has rendered sterling support to the HANSA programme. Its other achievements this year include the development of

⇨ *Figure 7 Composite tooling for LCA air intake models. NAL's capability in making carbon composite wind tunnel models is now widely applauded.*

⇧ *Figure 5 A KSRTC bus modified to minimize aerodynamic drag. The initial field trials of the prototype buses have yielded encouraging results in terms of fuel savings.*

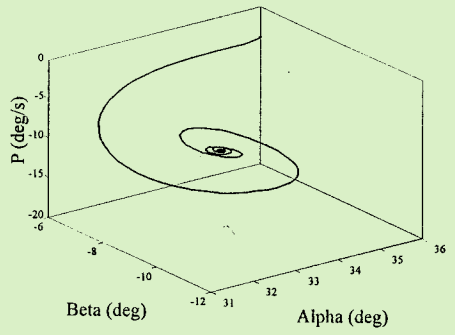


⇧ *Figure 6 A typical result from the project on modelling and flight data based identification of ALH dynamics.*

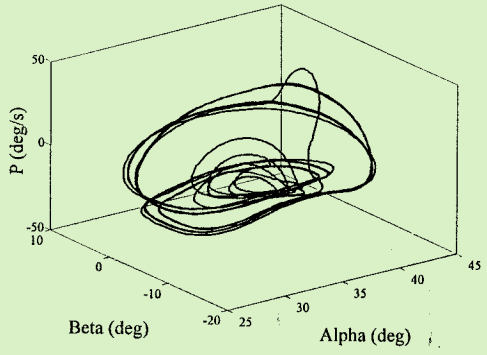
3. High Angle-of-Attack Flight Dynamics of a Fighter Aircraft / A A *Pashilkar*

Flight dynamics at high angles-of-attack is nonlinear in nature. Tools from nonlinear dynamics provide a powerful aid in understanding problems of flight dynamics at high angles-of-attack. The ability to model unsteady aerodynamic characteristics of fighter aircraft is critical to understanding and coping with the problems at high angles-of-attack. Large amplitude motions of aircraft configurations give rise to non-linear behaviour in the aerodynamic characteristics. The dynamic derivative approach is incapable of capturing this behaviour.

Nonlinear differential equations can be used as a basis for modelling large amplitude unsteady aerodynamics. The unsteady mathematical model contains, within itself, the quasi-steady data as a limiting case. Such models are useful for the simulation and analysis of aircraft dynamics at high angles-of-attack. To understand the qualitative effect on the dynamics of the fighter aircraft at high angles-of-attack, the aerodynamic model incorporating large amplitude unsteady data is compared to one consisting of the conventional quasi-steady data alone. A five degree-of-freedom simulation was set up with both the aerodynamic models. It is seen that at this flight condition (incidence = 35 deg and sideslip = -8 deg), simulation with the quasi-steady aerodynamic data results in a stable behaviour. Under an initial disturbance condition, the aircraft model tends to return to the equilibrium point. A similar simulation with the unsteady aerodynamic model does not show any tendency to return to the equilibrium point. Instead, the state-space trajectories tend to converge to a limit cycle. Therefore, there can be a significant impact on the stability of such aircraft at high angles-of-attack due to the unsteady aerodynamics. Work is under way to improve the aerodynamic modelling of fighter aircraft configurations at moderate and large angles-of-attack.



Portrait of Alpha-Beta-Roll Rate : Quasi-Steady Aerodynamic Model



Portrait of Alpha-Beta-Roll Rate : Unsteady Aerodynamic Model

the 12.88 diameter sandwich panelled radome for ISRO's Doppler weather radar (as an inter-divisional project), different versions of carbon composite LCA air intake models for wind tunnel testing (*Figure 7*) and an all-composite sound treated FRP bus body. In spite of its pressing project obligations, the Pilot Plant is still able to pursue useful R&D studies in relevant areas such as composite curing, hygrothermal conditioning and effects and NDT evaluation.

The *Materials Science Division* continues to be involved in the development of materials and systems, which are of importance to aerospace and other related areas. The Failure Analysis and Accident Investigation Group undertook 54 investigations (30 for the aerospace sector) in 1999-2000. The Indian Navy found the upgraded Automatic Visual Range Assessor (AVRA MK 2) suitable for induction after a thorough assessment. The Division has also developed methods for providing ceramic thermal barrier linings for conical metal parts and for simultaneous synthesis and centrifugal castings of intermetallics.

The *National Trisonic Aerodynamic Facilities* conducted 1159 blowdowns in its 1.2m wind tunnel during 1999-2000 (up from 819 blowdowns in 1998-99). NAL accounted for the largest number of runs (450); many of the tests were to assess the flow quality improvement after last year's refurbishment programme. The major testing campaigns included LCA air intake performance tests (*Figure 8*) and tests to study multi-booster launch vehicle aerodynamics.

The *Propulsion Division* is involved in major R&D programmes in the areas of turbomachinery research, mechanical turbomachinery, com–

bustion and heat transfer and propulsion and energy systems. The year under review was characterised by consolidation of the Division's R&D projects. Scientists from the Division also participated actively in two international workshops: the Fifth NAL-CAE Workshop on Advanced Gas Turbine Technologies and the NAL-DLR Workshop on Experimental Fluid Mechanics and Turbo-machinery.

The *Structural Integrity Division* executed several important projects last year. These include: extensive structural testing of all the components of the HANSA-3 and testing of the LCA composite wing box at the Division's component test rig (*Box 5*). The Division has also commenced a major project for the Indian Air Force to undertake full-scale fatigue testing (*Figure 9*) for the life extension of its ageing MiG-21 bis aircraft. A 24-channel servo-hydraulic test controller has been designed for the purpose with appropriate control software.

The *Structures Division* was one of the major supporting arms of the HANSA and SARAS programmes last year. Its Structural Analysis Group was closely involved in the stress analysis of the SARAS wing, fuselage and engine mount and stub wing. The Group also worked on the modelling, analysis and flat pattern generation for ADRDE's aerostat project and on studies on the DWR radome. The Division's Mechanical Design Group participated in several design exercises relating to Kaveri air intake models, DWR radome and the 4m x 8m autoclave. The Division also carried out vibration studies on the tail rotor blade of the Mi-8 helicopter to determine predominant modes for dynamic strain measurement.

The *Surface Engineering Unit*

4. Flosolver Mk 5 / *Dr U N Sinha*

The 32-processor Flosolver Mk 5 was formally unveiled on National Technology Day (11 May 2000). Built around 32 Pentium II and III processors, the latest Flosolver offers high speed connectivity via an indigenously designed switch (the slower Ethernet connectivity is also available).

The basic objective of Flosolver Mk 5 was to build a fast parallel machine which could "scale up" flow calculations "almost linearly" (i.e. if eight processors work in parallel, then the processing time must increase almost by a factor of eight). Most current parallel machines (including NAL's Mk 4 version) scale up comfortably up to about four processors for flow calculations, but with, e.g., eight processors, the performance drops so rapidly that the very rationale of parallel processing is defeated. With Flosolver Mk 5 we hope to achieve near-linear scale-ups by using "intelligent" switches which will minimize inter-processor communication times. The basic concept is that both processing and communication (and not processing alone) will occur in parallel; this way the fast processors will "processing", not "waiting", most of the time.

⇩ *Figure 8 LCA model installed in the 1.2m trisonic wind tunnel to study air intake performance. The tests were undertaken to establish some of the individual effects of forebody change, air data sensors installed on the forebody, aft-spill door, nose chine and LEVCON.*

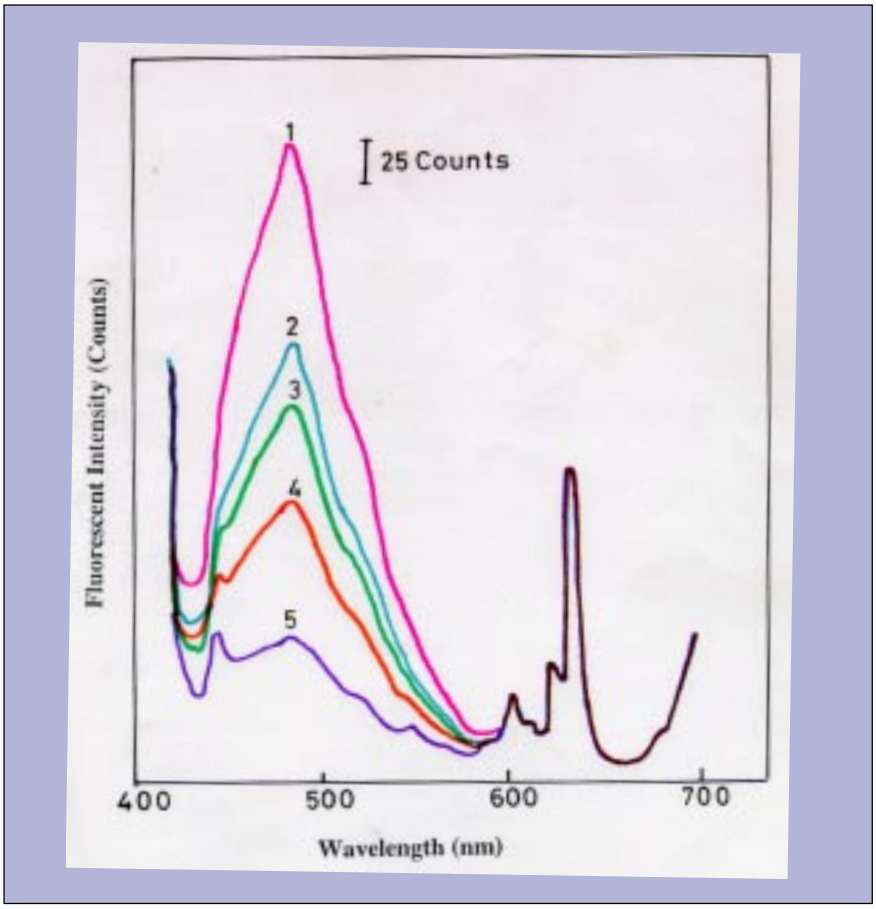
⇩ *Figure 9 A view of the full-scale fatigue test set-up for a fighter aircraft under test for fatigue life extension at the Structural Integrity Division.*

5. LCA Composite Wing Box Test / *Dr B K Parida*

The Light Combat Aircraft (LCA) has been designed to fly with wings made of advanced carbon fibre composites. It is necessary to demonstrate the structural integrity of these wings by actual testing up to the design ultimate load (DUL). The National Team, CFC-Wing, entrusted the Structural Integrity Division (SID) with this responsibility. Several test boxes, representative of LCA-wing box construction, were evaluated both under room temperature and under hot-wet environmental conditions. Since epoxy-matrix based composites normally exhibit strength degradation with moisture absorption, and at elevated temperatures, carrying out the hot-wet test on the LCA-skin buckling box and outboard pressure box was a mandatory requirement for the airworthiness clearance of LCA prior to its first flight. The tests have been successfully completed in the SID component test rig. The photo on the left shows the test set-up for the LCA outboard pressure box test under the room temperature condition while the photo on the right shows the set-up under hot-wet environmental condition. Incidentally, the hot-wet test involved prior moisture conditioning of the test box up to 1.5% moisture gain in an environmental chamber over a period of almost one year. Such complex component level hot-wet tests have been performed at NAL for the first time in the country.

continued to make notable contributions to the aerospace, energy, transport and general engineering sectors. In a remarkable investigation undertaken for Central Electronics Limited (CEL), the Unit developed an innovative process for the deposition of copper for deep buried contacts which resolved a major production bottleneck (*Box 6*). The Unit's project to develop pressure sensitive paints (PSP) is continuing (*Figure 10)*; the emphasis this year was on developing a PSP based on a luminophor which could be excited by ultra-violet radiation.

Finally, the *Wind Energy Programme* continues to offer advice on micro-



⇨ *Figure 10 A typical result from the investigations in the Surface Engineering Unit relating to the development of pressure sensitive paints.*

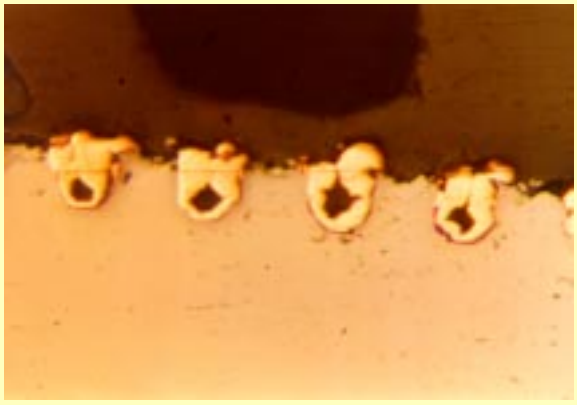
6. Development of a Process for Deposition of Copper for Deep Buried Contacts / *Dr Indira Rajagopal*

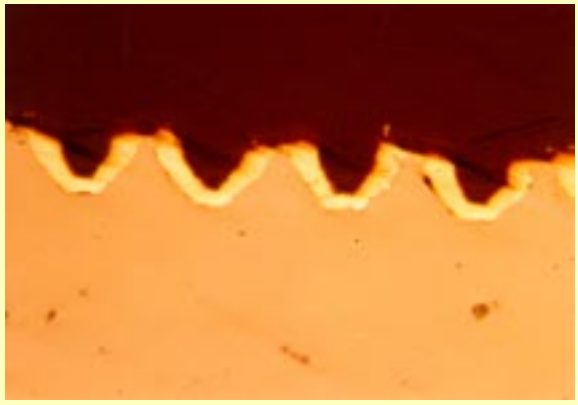
The Central Electronics Ltd. (CEL), Sahibabad, has started manufacture of ultra high efficiency silicon photo voltaic cells using Martin Green's deep buried contact method. This is a laboratory process that essentially consists of grooving the silicon surface with a laser beam and then filling the groove with copper by electroless plating. The Martin Green process had two serious drawbacks from the production point of view. It took 8 hours to get about 12 mm copper deposits in the groove and the deposit formed big nodules at the entrance of the grooves which frequently led to the formation of internal voids. CEL was keen to make the process commercially viable and was, therefore, interested in the development of a high speed electroless copper bath. CEL therefore asked Surface Engineering Unit to undertake a project titled "High Speed Electroless Copper Deposition for the Manufacture of Ultra High Efficiency Solar Cell".

A high-speed bath was developed. It was found that such a bath alone was not enough to yield significant deposition inside the groove. Increasing mass transport by stirring and ultrasonic agitation also did not throw the deposit inside the groove. On the contrary, it led to enhanced nodule formation at the entrance of the groove and thereby increased the tendency for void formation by the nodule covering the top of the groove (see figure on the left).

The problem was solved by an entirely different approach: by using additives. By scientifically studying the role of additives in electroless deposition, it was possible to identify suitable additives – one for increasing the rate of deposition and the other for suppressing the nodules. Two additives in synergy created wonders; using them it was possible to get uniform deposits inside the grooves (see figure on the right) and the deposition could be achieved in four hours.

The project has been successfully completed and the process has been transferred to CEL for implementation.





siting, long term testing and evaluation of wind farms to a large number of industries. The Group has been particularly successful with its power curve testing technique in which the power curves specified by the manufacturer are actually verified at field installations in typical user environments. NAL's experiments at Antarctica during the last two years established that wind energy offers interesting options. Following this success the National Centre for Antarctic and Ocean Research has now asked NAL teams to support its Antarctica field stations for communication, data logging and other services.

TECHNICAL SERVICES

The *Computer Support and Services Division* provided valuable support in uninterrupted power supply (UPS), networking, e-mail and Internet services. These services are now provided 24 hours, 7 days a week and throughout the year. The Division continued to offer its very successful training programme on computers and networks for NAL staff members. The *Engineering Services Division* was totally engaged in the manufacture of tools, fixtures and components for the SARAS project. It also participated in projects to fabricate 1/4 and 1/7 scale Kaveri air intake models and in the erection of the Doppler weather radar (DWR) radome at its test site. The *Estates and Building Unit* continued to support a wide variety of R&D programmes; the major construction project relating to the LCA fuselage and wing development programme (Phase II) was completed last year. The *Information Centre for Aerospace Science and Technology* completed the important project to

7. Library Automation and other ICAST services / *Poornima Narayana*

The task of creating a database of all the books, journals, reports (including microfiche reports) and patents available at the Information Centre for Aerospace Science and Technology (ICAST) has finally been completed. This mammoth task, using the Libsys software, of automating information about more than 2.5 lakh publications, and offering online access to this information, took almost two years to complete. Using this service, ICAST users can, from their desktops, (a) search documents by author, title, class number, keywords, (b) obtain information about issue and reservation status and (c) be alerted about recent arrival of journals. Public access is normally via the Web, but additional specialised services are offered only to NAL users via telnet.

Several other innovative information services are also offered by ICAST on its "*AeroInfo*" web site. These include (a) access to full text journals (from Elsevier, Springer-Verlag, Kluwer, Francis & Taylor) either directly or via ICAST-registered logins, (b) on-line access to the table of contents of many hundreds of S&T journals of interest to aerospace researchers (links through pages created in-house by ICAST), (c) newspaper clippings covering topics such as aerospace, CSIR labs, general S&T, specific aspects of S&T etc. and (d) a pre-paid IP-enabled service for NAL users offering access to over a dozen international databases in materials science and aerospace hosted by the International Database Service of Cambridge Scientific Abstracts (IDS/CSA).

create a database of all its books, journals and reports (including microfiche reports). The database now has over 3 lakh records. The Centre is also offering several new Web-based services on the NAL campus-wide network and its *AeroInfo* web site (*Box 7*). The *Information Services & Systems Section* (now renamed the "Information Management Division") developed a new web-enabled, Y2K-ready payroll application system using the Oracle software. The *Project Monitoring and Evaluation Section* had another busy year. In spite of an overall difficult financial situation, the Section helped NAL reach a new high of Rs 54 crores in its external cash flow. The Section also took up several proposals for facility modernization including the major proposal to modernize NTAF's wind tunnels. The *Technical Secretariat* continues to re-orient itself strongly towards IPR-related issues. Six patents went finalized and sent to CSIR for filing during 1999-2000; two copyrights were also registered during the same period. The Secretariat also assumed the leadership in supporting the CSIR Programme on Youth for Leadership in Science (CPYLS) at NAL. NAL's efforts to obtain the ISO-9001 certification are progressing well. We hope to become an ISO-certified R&D establishment well before the end of 2000.

OTHER EVENTS

Prof V S Ramamurthy, Secretary, Department of Science and Technology (DST) delivered the thirteenth NAL Foundation Day Lecture on 18 August 1999 (*Figure 11*). In a masterly lecture Prof Ramamurthy identified the three steps involved in the passage of an S&T concept to the marketplace. Dr Shivakumara Swamy's Third NAL Technology Lecture recounted the fascinating adventure of the design, development, fabrication, test flight and certification of the HANSA aircraft.

To celebrate NAL's achievements in materials science, this year's CSIR Foundation Day function featured

⇨ *Figure 11 Prof V S Ramamurthy, Secretary, DST, delivering the thirteenth NAL Foundation Day Lecture on Concept to Commercialisation — DST Initiatives.*

⇨ *Figure 12 The 1999 CSIR Foundation Day was "Materials Science Day" at NAL. The function featured three illuminating lectures (top to bottom) by Dr A K Singh, Dr A C Raghuram and Dr S R Rajagopalan.*

special lectures (*Figure 12*) by three of the pillars of NAL's Materials Science Division: Dr A K Singh on *New Materials Development — Challenges*, Dr A C Raghuram on *Role of Failure Analysis in Flight Safety* and Dr S R Rajagopalan on *Surface Modifications with Nano Materials — An Emerging Area.* It was a special pleasure to greet Prof S Ramaseshan on this occasion.

The 2000 National Science Day Lecture was delivered by Prof N Balakrishnan, Chairman, SERC, Indian Institute of Science, on *Information Science and Technology for the 21st Century* while the Seventh Dr B R Ambedkar Birthday Lecture was delivered by Dr Selvie Das on *Dr B R Ambedkar and his Contribution to the Nation* (*Figure 13*). Mr S N Singh, Joint Director, Central Translation Bureau was the chief guest at this year's Hindi Day function which also featured the Third Hindi Day Lecture by Prof B K Parida on *Rejuvenation of Ageing Aircraft*. The chief guest at this year's Karnataka Rajyothsava function was the eminent litterateur D G S Shivarudrappa.

As always, NAL also hosted a large number of international and national scientific meetings during 1999-2000: the NLR-DLR Workshop on Experimental Fluid Mechanics and Turbomachinery (10-20 January 2000); a week-long training programme on CSIR administrative practices (19 April 1999); the Thirteenth AGM of ISAMPE (10 September 1999); the Seventh Training Programme on FRP Moulding (20 March 2000); and a One-Day Symposium on X-Ray Diffraction and Materials in honour of Dr A K Singh (3 December 1999). Among the many distinguished visitors to NAL last year was Dr V K Aatre, who has now taken over as the Scientific Adviser to the Raksha Mantri (*Figure 14*)

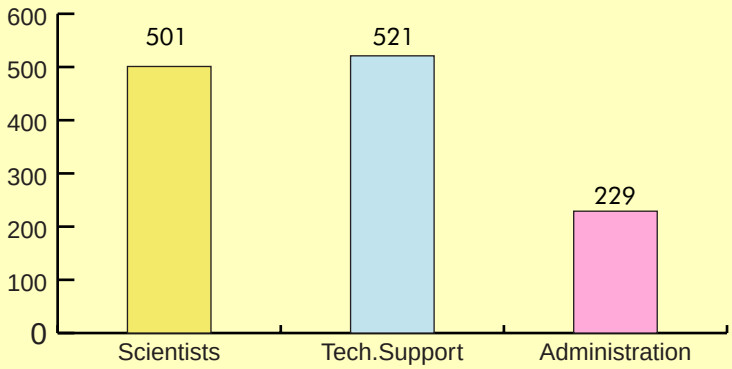
STATISTICAL SUMMARY

The NAL staff strength as on 31 July 2000 was 1251. This includes 501 scientists (Group IV: 339, Group III: 162), 521 in the technical cadre and 229 in the administrative cadre. *Figure 15* depicts the relevant details graphically.

⇧ *Figure 13 Dr Selvie Das, who was the chief guest at the Dr B R Ambedkar Birthday Celebration function, seen with Dr T S Prahlad.*

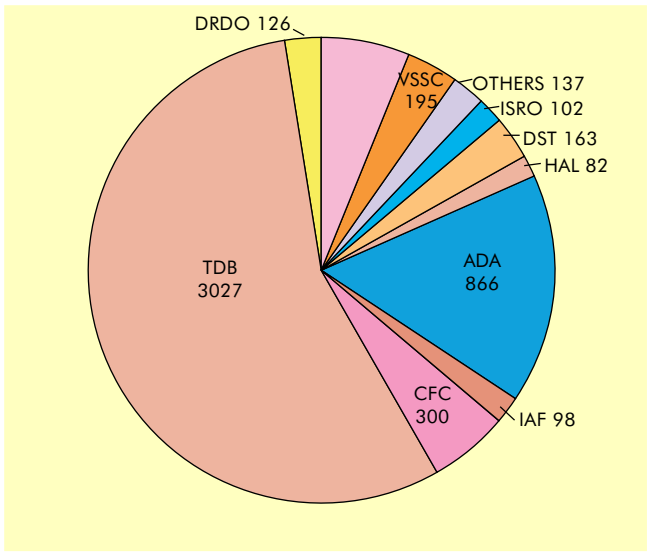
⇧ *Figure 14 Dr V K Aatre, SA to RM (arms folded) checks out the flight simulator in the Flight Mechanics and Control Division when he visited NAL in January 2000.*

⇨ *Figure 15 Break-up of NAL's current staff strength in terms of scientific, technical and administrative cadres. 339 out of the 501 scientists belong to the Group IV cadre.*

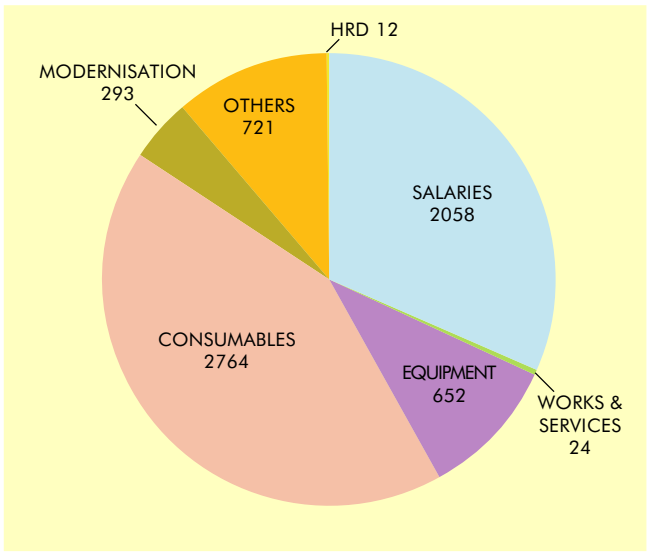


64 new sponsored projects (value: Rs 1864 lakhs) and 6 new grant-in-aid projects (value Rs 1856 lakhs) were taken up during 1999-2000. Our external cash flow (ECF) this year (*Figure 16*) was Rs 5429 lakhs,

⇩ *Figure 16 Rs 5429 lakhs were received from external sources during 1999-2000 (up 73% from the previous year). 56% of this money came from the TDB for the SARAS programme.*



⇩ *Figure 17 NAL spent Rs 6524 lakhs on its R&D programmes in 1999-2000 (up 73% from the previous year), of which consumables accounted for 42% and salaries for 32%.*



including Rs 3027 lakhs from the Technology Development Board for the SARAS programme. This is an all-time high for NAL. The ECF component from ADA is now 21%; last year it was 60%.

NAL actually spent Rs 6524 lakhs (*Figure 17*) in 1999-2000 (up 73% from the previous year). 32% of this expenditure was for salaries, 42% for consumables and about 14.5% was spent on capital equipment under various budget heads. Expenses on consumables are steadily rising, largely because of NAL's greater involvement in aircraft prototype development.

HONOURS

It is finally a pleasure to mention the distinctions won by my NAL colleagues: Dr Gangan Prathap (who has now moved over as Scientist-in-Charge, C-MMACS) received the Distinguished Alumnus Award from IIT, Madras. The Orissa Science Academy awarded Prof B K Parida the Samanta Chandra Sekhar Award. Dr Indira Rajagopal was elected President of the Royal Society of Chemistry (Deccan Section). Dr T G Ramesh received the MRSI Medal for 2000. Dr Arun Kumar received the Mechanical Engineering Design Award from the Institution of Engineers (India). Ms Padma Madhuranath was chosen by the FICCI Ladies Organization as the Outstanding Woman Professional in 1998-99. Ms Chinmayee Madhavan received the Indigenising of Aeronau–tical Equipment Award 1999 of the Aeronautical Society of India. Dr K Bandyopadhyay and Mr M R Rama–murthy received an appreciation award from ISAMPE for their work on smart technology development. I congratulate all of them.

Dr T S Prahlad
Director