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REPORT OF THE DIRECTOR

It gives me great pleasure to present the annual report for the year 2000-2001.

HIGHLIGHTS

India's Light Combat Aircraft (LCA) took to the skies on 4 January 2001 (*Figure 1)*. I was privileged to witness LCA's first flight. It was a very proud moment for the country and especially for Aeronautical Development Agency (ADA). NAL too can take great pride from its many important contributions to the LCA programme *(Box 1).* We still have a very long way ahead in the LCA programme but the success of the first block of LCA test flights is most encouraging and gives us all a very high level of confidence.

On 8 May 2001, the HANSA aircraft (VT-HNT) was ferried to the Andhra Pradesh Flying Academy (APAA). It is a matter of great satisfaction to all of us that the HANSA (*Figure 2*), which was primarily designed for flying clubs, is now actually flying at a Hyderabad flying club. This is the first of the three aircraft ordered by the DGCA, to position at Indian flying clubs (*Box 2*). The next two aircraft ordered by DGCA (which will be the sixth and seventh HANSA aircraft to be built at NAL) will also be ready very soon.

Work on our 14-seater multi-role SARAS aircraft is now in top gear (*Box 3*). Major activity is now under way at NAL, HAL, TAAL and 30 other work centres to manufacture, assemble and equip major modules of the first prototype. Many of the structural assemblies of the aircraft are now ready (*Figure 3*). The SARAS programme faced certain difficulties in view of some export restrictions; we have overcome most of these problems and expect the aircraft to fly within a few months, although there are still one or two critical problems which have an impact on the first flight schedule.

We have now prepared a comprehensive draft of the Tenth Five-Year Plan for the Aerospace Sector of CSIR. This draft, prepared after detailed presentations to a Committee chaired by Dr V K Aatre, SA to RM, recognizes that NAL's unique strength lies in its vibrant mix of research, development, technology and mission mode activities. The draft, while being ambitious, also recommends that NAL must excel in a few core areas of competence.

I am happy to report that NAL is now an ISO 9001 certified organisation.

⇩ *Figure 1 The LCA takes off on its maiden flight on 4 January 2001.*

NAL formally received its ISO certification on 22 September 2000 from the Lloyd's Register Quality Assurance (LRQA). I also note with happiness that the NAL-led multi-organisational proposal on "meso–scale modelling for monsoon-related predictions" has been recommended for the New Millennium Indian Technology Leadership Initiative (NMITLI) Award.

IN THE DIVISIONS

The major activity at the *Advanced Composites Unit* related to the LCA and SARAS aircraft development programmes. For the LCA programme, the fabrication, certification and supply of all the CFC wing spars, fairing skins, fairing blocks, co-cured co-bonded fin and centre fuselage components, for use on the PV1 aircraft, is complete. For the SARAS project most of the CFC components required for the assembly of the elevator, rudder and aileron (*Figure 4)* have been completed. Under its repair technology programme, the Unit successfully developed a CFRP belly fairing for the MiG-29 aircraft. Flight trials with the repaired component have been successful.

The *Aerospace Electronics and Systems Division*, which has the full responsibility of delivering the SARAS avionics system, has successfully completed the Phase I integration of the avionics equipment using a specially designed pre-shipment test rig. The Division is also busy with the design and development of the SARAS autopilot, stall warning system and the aircraft interface computer. In another important development, the electro-mechanical fatigue meter, developed by the Division for aircraft life extension, has successfully undergone all type tests required for its airworthiness certification. Flight tests on a Jaguar aircraft have also been completed (*Figure 5*).

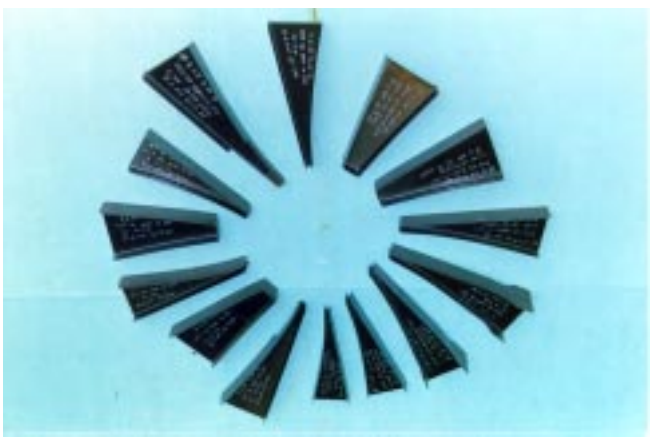
As mentioned earlier, the major focus of activity at the *Centre for Civil Aircraft Design and Development* during the year has been the fabrication and assembly of the production version of HANSA, to fulfil an order from the Ministry of Civil Aviation for delivery to flying clubs, and the manufacture of parts and assembly for the components of the SARAS prototype. Work is also in progress at the Centre for the design and development of a micro air vehicle (MAV).

Several new areas for study have been identified at the *Computational and Theoretical Fluid Dynamics Division*. These include liquid sloshing in containers, fluid flow under micro-gravity conditions, 3D unsteady

⇧ *Figure 2 The HANSA aircraft (VT-HNT) is now flying at the Hyderabad Flying Club.*

⇩ *Figure 3 The major SARAS assemblies being integrated.*

⇩ *Figure 4 LH and RH aft ribs of the SARAS aileron fabricated at the Advanced Composites Unit.*



1. NAL's contributions to LCA

There was great happiness at NAL following the first flight of the LCA on 4 January 2001. The aircraft has since completed its first block of 12 test flights.

NAL and NAL-led teams have played a major supporting role in the development of LCA (see the cover page of this report which identifies some of the major LCA-related projects undertaken at NAL). Most of the composite structures of LCA such as the fin, rudder, centre fuselage, landing gear etc. have been developed at NAL. CFC wings for the LCA were also designed and developed by a national team led by NAL. Practically every LCA wind tunnel model has been fabricated at NAL (including the 1/4 scale high speed air intake model built in 1990 against all odds, and numerous 1/7 scale composite models). These models have then been extensively tested at NAL's trisonic wind tunnel (many hundreds of wind tunnel tests have been undertaken spanning a whole decade). The LCA control law was completely designed and developed by a national team led by NAL (The success of the first block of test flights confirms that the safe, robust "inner loop" of the control law is performing well). NAL teams have also undertaken projects for the aeroelastic testing of LCA models and carried out numerous CFD calculations to study LCA's configuration and the associated flow properties.

⇧ *Figure 5 The type-certified electro-mechanical fatigue meter mounted in the undercarriage of the Jaguar aircraft for a flight test.*

flow simulations as the basis of the large eddy simulation (LES) codes, for the near future, and fluid-structure interaction problems. The Division continues to undertake valuable analysis for DRDL, NSTL and ADA (*Figure 6)*.

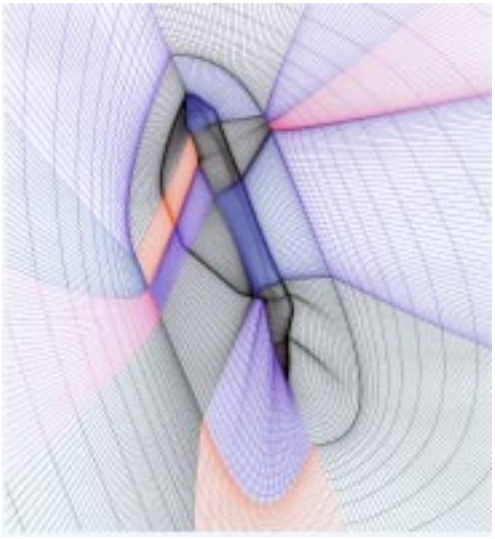
At the *Experimental Aerodynamics Division* a fair part of research work continued to focus on topics such as boundary layer transition, relami–narization and separated flows. In the area of flow diagnostics, a novel pressure measurement technique, based on pressure sensitive paints (PSP), was established, and the first PSP measurements were made in the 1.2m trisonic wind tunnel (*Box 4*). The Division also used digital particle image velocimetry (DPIV) in the measurement of the velocity field of an elliptic jet at low speeds (*Figure 7).*

The focus of activity at the *Flight Mechanics and Control Division* continues to be the development of the LCA control law and the SARAS autopilot. The LCA TD-1 first flight standard control law was formally certified for flight testing earlier in the year. It is a matter of great satisfaction that the first block of LCA test flights have confirmed that the control law is performing well. The analysis of LCA flight test data has also been taken up to estimate stability and control derivatives. The preliminary results are very encouraging.

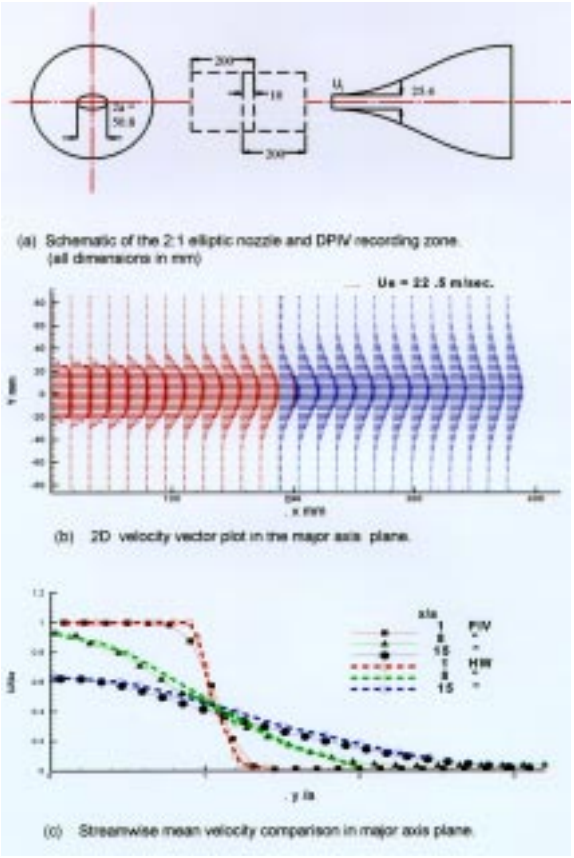
I have already mentioned the success achieved by the *Flosolver Unit* in winning the NMITLI award to build a parallel supercomputer for good weather prediction in the tropics. In another interesting exercise, the Unit undertook tests on the Flosolver Mk 5 to verify if the parallel computer could be used for the human genome project in association with CBT, New Delhi. Preliminary results indicate that Flosolver Mk 5 is admirably suited for matching strings of genome sequences.

The significant achievements at the *FRP Pilot Plant* this year were the fabrication of composite airframe components for the HANSA VT-HNT, development of X-band radomes for LRDE, fabrication of a FRP bus body for speech and hearing evaluation (*Box 5*) and the development of carbon composite LCA wind tunnel models for different versions of the Kaveri engine configuration. The team also conducted another successful training programme on FRP moulding for young entrepreneurs.

At the *Materials Science Division* significant progress was made in producing special fibres, for specific end uses, and in the development of special resins for producing unidirectional prepreg material. The Division's project to make monolithic ceramic components for critical systems has shaped up very well and should soon be completed. The technology for



⇧ *Figure 6 Sectional view of the grids around the LCA wing-body-fin. NAL continues to undertake valuable CFD analysis for ADA and other sponsors.*



⇨ *Figure 7 Digital particle image velocimetry measurements in a 2:1 aspect ratio elliptic jet.*

ceramic lining of components subjected to high temperatures has potentially very attractive applications in combustor nozzles. Upgraded versions of the Automatic Visual Range Assessor (AVRA) have performed very well in the field (*Figure 8)*. The Indian Navy is also seriously considering NAL's AVRA and has placed an order for two units. The Division's failure analysis group undertook 43 investigations last year.

At the *National Trisonic Aerodynamic Facilities (NTAF)* 707 blowdowns were carried out in the 1.2m trisonic tunnel and 168 blowdowns in the 0.6m wind tunnel. There were fewer blowdowns this year due to a breakdown of some critical parts in the tunnel, which were subsequently rectified. NTAF is currently entering a major augmentation programme aimed at enhancing capability, increasing productivity and improving data quality (*Figure 9)*. NTAF's 1.2m tunnel is an extremely valuable national facility and I am glad that funds have been made available by CSIR, DRDO and ISRO to upgrade this unique facility.

An important event at the *Propulsion*

2. VT-HNT flies off to Hyderabad / *R Rangarajan*

One of the major objectives of the HANSA programme, started a decade ago, was to build a modern all-composite trainer that Indian flying clubs could use. Following the HANSA type certification on 1 February 2000, the DGCA placed an order for three HANSA aircraft to be positioned at different flying clubs in India.

For NAL, therefore, it was a matter of deep satisfaction when Dr T S Prahlad, Director, formally handed over the keys and documents of the HANSA VT-HNT aircraft to Mr N S Munday, Director (R&D), DGCA. This is the first of the three HANSA aircraft ordered by DGCA. On 12 April 2001, the DGCA, in turn, handed over the HANSA VT-HNT to the Andhra Pradesh Aviation Academy (APAA). Mr H S Khola, DGCA, personally flew down from Delhi to hand over the keys of the aircraft to Capt S N Reddy, Secretary, APAA and Special Secretary, Government of Andhra Pradesh.

The HANSA VT-HNT aircraft was ferried from Bangalore to Hyderabad (via Bellary, for refuelling) in May 2001. The aircraft was flown by Wg Cdr P Ashoka and Capt K K Sharma (of APAA). A small support team from NAL was also stationed at Hyderabad for a few weeks thereafter.

3. SARAS getting ready to fly / *Dr K Y Narayan*

Work on the SARAS project is now in full swing to manufacture, assemble and equip major modules of the first prototype. Major SARAS related activities are now underway at NAL, HAL, TAAL and 30 other work centres in and around Bangalore. Major structural assemblies of the aircraft are now ready; in particular three numbers of horizontal tail, two numbers each of vertical tail and rear fuselage, one each of centre and front fuselages and three emergency doors have been completed. The wing assembly has commenced at HAL (Nashik). The rear, centre and front fuselage modules of the first prototype have been mounted on the fuselage coupling jig at NAL. In addition, a large number of carbon fibre composite components viz. elevator, aileron and rudder have been assembled. Structural tests on the horizontal tail and elevator have been conducted with the participation of DGCA representatives. The trial equipping of the rear fuselage consisting mainly of the line replaceable unit (LRU)'s of the environmental control system, fire sensing system and flight control system has now been completed. There are some procurement difficulties; all attempts are being made to solve them.

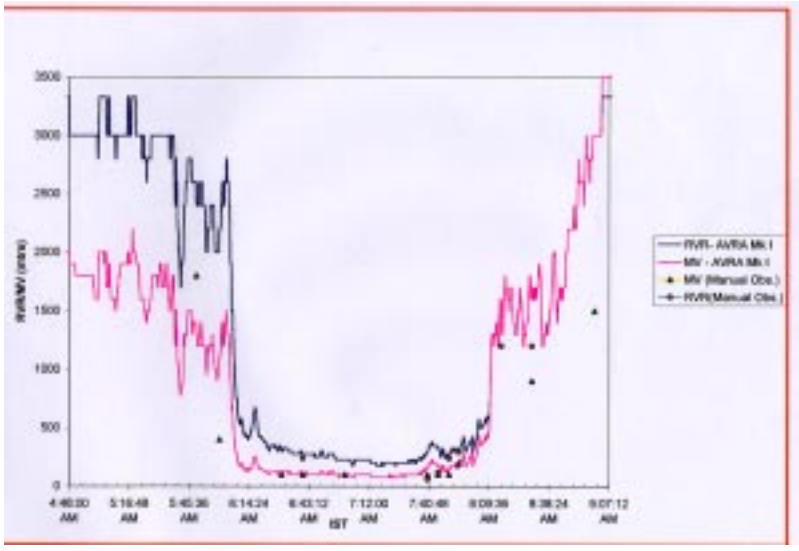
Ground tests on the environmental and cabin pressure control systems and fuel system have been completed. The first phase of the avionics system integration and testing on a ground test rig has been completed. The hydraulic system test rig is being set up in NAL and the electrical system test rig too has been established at HAL (Lucknow).

Reliability and safety assessment studies were continued by the Aeronautical Development Agency under a Memorandum of Understanding signed with NAL. Most of the system level reliability analysis has been completed.

Division this year was the signing of a MoU with Vikram Sarabhai Space Centre (VSSC) for investigations relating to the development of combustors for air breathing propulsion systems. The Division's axial flow transonic compressor test rig has been upgraded and is now capable of testing stages with very high tip speeds; this should open up new areas of investigation such as high pressure ratio and highly efficient machines. The Division also organized a successful AR&DB workshop on CFD in internal flows. The powered hang gliding activity continues to do very well.

The *Structural Integrity Division* executed several important projects this year both for the defence and civil sectors. These include life extension studies on the MiG-21bis aircraft and the tail rotor blade of the Mi-8/Mi-17 helicopter, evaluation of the bearing strength of CFC laminates under room temperature and hot/wet conditions, static strength test of the LCA wing skin with and without panels and the structural testing and damage tolerance evaluation of the SARAS airframe (*Figure 10)*.

The *Structures Division* continues to support the SARAS programme in a variety of ways, especially in structural analysis and the prediction of the aircraft's flutter and dynamic characteristics. An integrated analysis of the wing with the fuselage in the support region led to a design improvement near the wing-fuselage attachment region. The integration of edge-consistent quadrilateral elements with the FINESSE finite element software was completed with validation and documentation. Other highlights of the year include the recommissioning of the devine autoclave (*Figure 11*) and significant contributions towards the formulation of a national civil aviation policy.

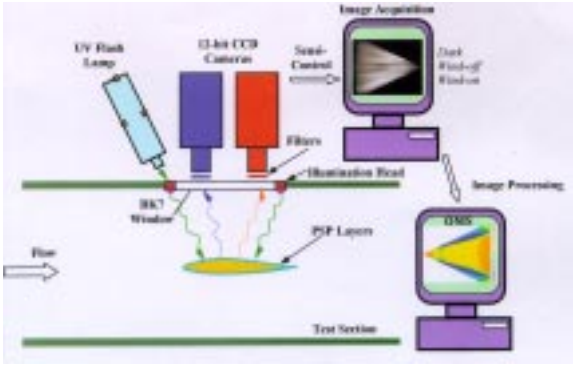


⇦ *Figure 8 Runway visual range (RVR) and meteorological variability (MV) reported by the upgraded AVRA Mk 1 at HAL Airport, Bangalore.*

4. Advanced flow diagnostics / *Dr P R Viswanath*

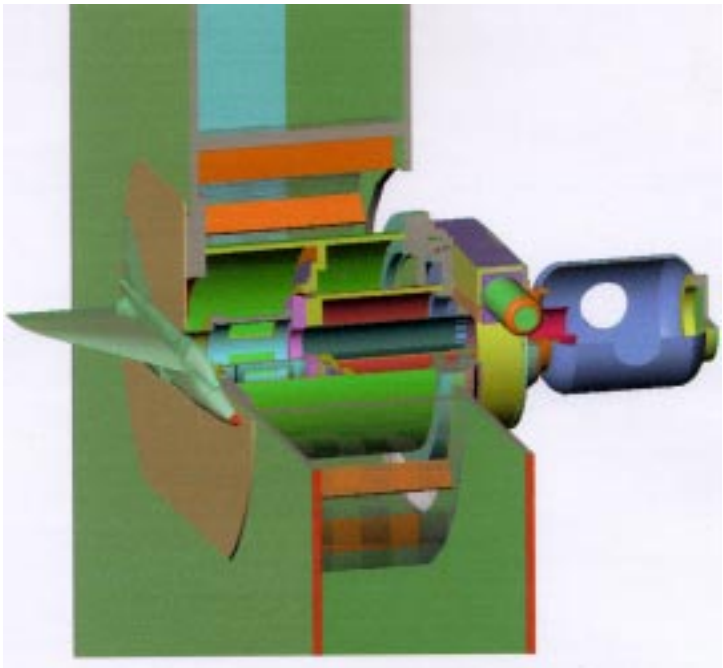
A major thrust in the Experimental Aerodynamics Division is on advanced flow diagnostics and their application to the understanding of complex flow problems. Significant developments on two experimental techniques took place during the year. A novel pressure measurement system based on pressure sensitive paints (PSP) was established with the assistance of the DLR, Goettingen. The system consists of a specially designed UV illumination source, two 1Kx1K slow scan CCD cameras, an image processing software and a compact apparatus for accurate calibration of PSP samples. The first PSP measurements at transonic speeds on a delta wing-body model were made in the 1.2m trisonic blowdown wind tunnel, using both OPTROD B1 as well as NAL G-type binary paints. The results obtained by the two paints showed excellent consistency. Plans for the current year include tests on a generic aircraft model, development of a method to correct PSP images for the drop in tunnel total temperature during a blowdown as well as application of PSP at low speeds.

Digital particle image velocimetry (DPIV) was successfully used in the measurement of the velocity field of an elliptic jet at low speeds. The PIV system uses a Nd-Yag 400mJ, double pulsed laser (Spectra Physics), a 1Kx1K cross correlation CCD camera and an image processing software. Realistic flow problems will be studied in a large wind tunnel using PIV in the current year.



Schematic of NAL's pressure sensitive paint (PSP) system

⇨ *Figure 9 Proposed half model support system for the 1.2m trisonic wind tunnel.*

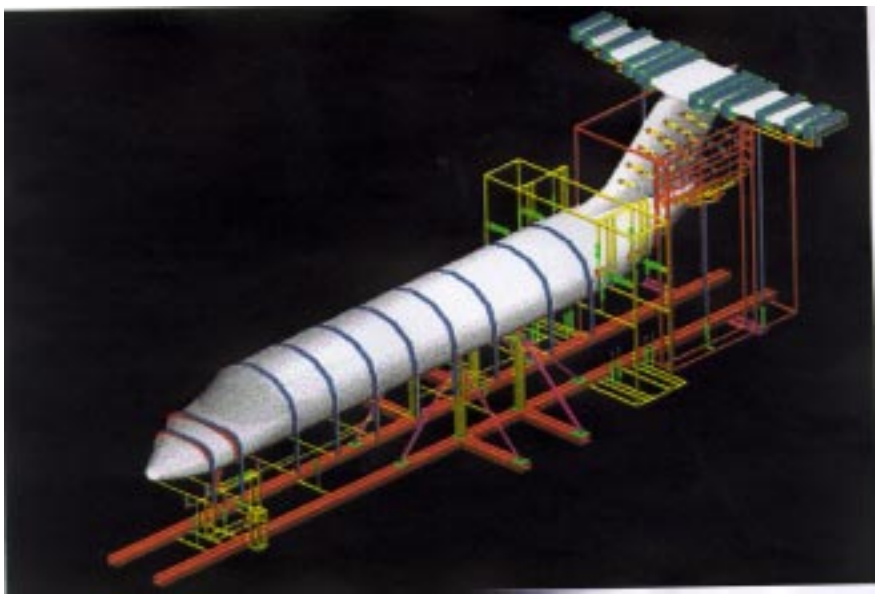


The *Surface Engineering Unit* developed a candidate binary paint, named NAL-G, as a pressure sensitive paint for wind tunnel testing. Early test results point to a very encouraging performance by NAL-G. In another important project for ITC, the Unit developed a process for the manufacture of embossing rollers for metal or foil wrappers (*Box 6)*.

The *Wind Energy Programme* continued its wind resource related studies (*Box 7*). The Group has met with considerable success especially in identifying windy sites in the North East. For Antarctica operations, the team experimented with a windmill meant for battery charging; the results so far are encouraging.

TECHNICAL SERVICES

The *Computer Support and Services Division* successfully completed the campus-wide networking programme this year with the help of Dr S Sridhara Murthy and his team. A high-speed switched network now connects the three NAL campuses at Kodihalli, Belur and C-CADD/C-MMACS round the clock. The bandwidth of the Internet leased link was increased from 128 kbps to 512 kbps, and our 500+ network users appear to be very happy with this service. The *Electrical Sections* on the two campuses continued to support NAL's major projects, notably the 4m x 8m autoclave project and the SARAS programme. We have also just completed the task of light-



⇧ *Figure 10 A conceptual test setup for the structural testing of the SARAS fuselage.*

ing up the road that leads to the Belur campus. The *Estates and Buildings Unit* was, among other things, involved in the construction of 60 additional scientists' apartments and the C-CADD annexe building. The *Information Centre for Aerospace Science and Technology (ICAST)*'s website *AeroInfo* is now even better; some of ICAST's new network based information services are the union catalogue of CSIR libraries and the connectivity to Elsevier's e-journals on a trial basis. ICAST also organised an immensely successful ITT'2000 meet. The *Information Management Division (IMD)* had another busy year. IMD prepared a multimedia presentation on the history of the Flosolver project. The NAL web site, managed by IMD, continues to be very popular. The NAL intranet now offers many more

⇧ *Figure 11 The re-commis–sioned devine autoclave. Practically the entire autoclave, except the main shell, had to be redesigned and rebuilt.*

5. Composite van for speech and hearing evaluation / *Dr R M V G K Rao, C Pragalathan*

In an interesting "spin-off application" of composites, NAL's FRP Pilot Plant collaborated with the All India Institute of Speech and Hearing (AIISH), Mysore, to develop a composite mobile van for speech and hearing evaluation.

Any medical evaluation of speech and hearing requires a sufficiently quiet room because environmental noise is a crucial parameter in testing and in interpreting test results. While there are hospitals and clinics in Bangalore or Mysore with low noise chambers, AIISH was severely handicapped while examining patients in the rural areas. The best that AIISH could do was to use relatively silent classrooms or panchayat halls.

NAL has now designed a "mobile" speech and hearing clinic for AIISH using a composite body. This composite van, which has three chambers for examining patients, has a sound level of only about 25 dB inside (the noise "outside" can be as high as 90 dB). This low sound level was achieved by determining the optimal density and thickness of the composite foam core and skin. With better internal acoustic treatment, the sound level could even be reduced to 10-15 dB.

Composite bodies achieve good vibration damping, use very few fasteners (both of which contribute to reduced noise levels inside) and also have lower production costs (because of inexpensive tooling). When we work on fabrication technologies in composites, we usually have planes on our minds. This composite mobile van is therefore a happy spin-off.

The "low noise" composite van designed by NAL can function as a "travelling clinic" for speech and hearing evaluation.

6. Embossing metal foil and metallised paper / *Dr K S Rajam*

One of the novel innovations at the Surface Engineering Unit (SEU) this year was the development of steel embossing rollers for ITC.

Embossing of metal foil and metallised paper is undertaken to produce aesthetically appearing wrappers. The wrappers are produced by feeding the foil or paper between rotating cylindrical rollers of diameters 60 mm and 120 mm respectively. The embossing width of these rollers is 75 mm and this area contains a large number of pins having the shape of a truncated cone of height 140 mm and a top diameter of 100 mm. The pin to pin distance is 0.4 mm. The smaller diameter roll has about 76,300 pins while the larger one has about 1,52,600 pins.

During embossing the crest of the pin of the top roller meshes with the trough of the pin of the bottom and the paper on the foil moves between the downward and upward pin resulting in embossing of the square pattern on both sides of the paper or foil.

The challenges in developing the rollers were to ensure excellent profile and pitch accuracy of the pins to get a uniform finish and high productivity. The surface of the pins was also required to be wear-resistant to provide longer life. It is interesting that even for an apparently simple looking application — essentially involving machining a very large number of tiny profiled pins, rounding off the top of the pins and hardening them by an appropriate surface modification treatment without distorting the shape and size of the pins – we still require innovative surface engineering.

The SEU-fabricated steel embossing rollers are currently undergoing evaluation trials at ITC.

information links and services. The *Project Monitoring and Evaluation (PME) Section* again helped NAL reach a very impressive external cash flow (ECF) figure. The Section was also required to migrate to zero based budgeting, manage the modernisation programmes and co-ordinate all the reviews associated with ISO certification. The *Technical Secretariat (TS)* filed ten patents during 2000-2001; four copyrights and two trademarks were also registered. TS also capably manages NAL's HRD programmes, international co-operation, public relations and guest houses.

OTHER EVENTS

Dr V K Aatre, SA to RM delivered the fourteenth NAL Foundation Day lecture on 12 August 2000 (*Figure 12*). In his illuminating lecture, titled "S&T in India: Present Scenario and Thoughts for the Future", Dr Aatre appeared cautiously optimistic. His basic message appeared to be: "we haven't done badly at all in S&T, but we can (and should) do much better". Dr S N Seshadri's Fourth NAL Technology Lecture highlighted the importance of wind tunnel testing in flight vehicle design and development.

The CSIR Foundation Day function on

7. Understanding the wind environment / *M P Ramesh*

NAL's Wind Energy Group, especially during the last decade, has contributed to a better understanding of the wind environment in India. For example, in the North East, which is generally known to have low wind activity, several sites were found with considerable potential. This is particularly important as some of the remote locations in North Sikkim can benefit from wind power generation. (North Sikkim remains cut off for weeks during monsoons and fuel shortages cause serious difficulties both for the armed forces and the local population). Similarly several sites have been recommended in the states of Assam, Manipur and Tripura.

Other initiatives of the Group include the introduction of wind energy systems in the Indian Antarctic station Maitri and the field camps (there is considerable interest and enthusiasm from the user groups working in the Antarctic), and the performance evaluation of wind turbines under actual operation (feeding into the grid). Some of the reasons for under-performance were investigated under a special programme undertaken for the Ministry of Non-Conventional Energy Sources.

Wind flagged trees in Assam?

⇧ *Figure 12 Dr V K Aatre, SA to RM delivering the fourteenth NAL Foundation Day lecture on "S&T in India: present scenario and thoughts for the future".*

⇧ *Figure 13 This year's CSIR Foundation Day was an occasion to highlight promising technology initiatives at NAL.*

26 September 2000, which featured six speakers (see *Figure 13*) was an occasion to highlight the recent, and very promising, technology initiatives at NAL. Prof V K Gaur delivered the 2001 National Science Day Lecture on ""The Bhuj earthquake: What can we learnt from it?" (*Figure 14)*. Prof Gaur observed that "it is usually buildings which kill, not the earthquake itself". The Eighth Dr B R Ambedkar Birthday Lecture was delivered by Mr Justice Chidananda Ullal, Hon.Judge, High Court of Karnataka (*Figure 15)*. Justice Ullal spoke on "Reservation policy and its evolution" to a packed audience at the S R Valluri Auditorium on 27 April 2001. The chief guest at this year's Hindi Day function was Dr H S Rana, Sr Manager (Personnel), N T C, Bangalore. Dr P Goswami, Scientist, CMMACS, delivered the fourth Hindi Day lecture on "Ocean and the atmosphere: an eternal coupling".

Other important events in 2000-2001 included the visit of Dr Murli Manohar Joshi, the Union Minister for HRD, S&T and Ocean Development, and Vice President, CSIR, on 30 May 2001 (*Figure 16*), the visit by Parliamentary Committee on Science and Technology, Environment and Forests, led by Mr C Ramachandraiah on 16 September 2000 (*Figure 17*), the Karnataka Rajyothsava celebrations at NAL on 22 December 2000 and the second CPYLS programme at NAL for high school toppers on 4-5 December 2000. NAL also participated in the fourth Bangalore air show during 7-11 February 2001 with the HANSA once again giving a charming flying display.

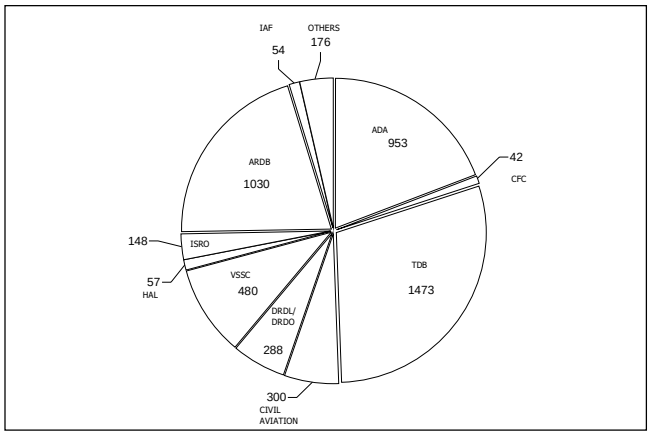
As a welfare measure, NAL now offers 10 graduate trainee and 10 diploma trainee positions every year exclusively for fresh graduates from the SC/ST community.

⇩ *Figure 14 The National Science Day lecture on "The Bhuj earthquake: what can we learn from it?" by Prof Vinod K Gaur.*

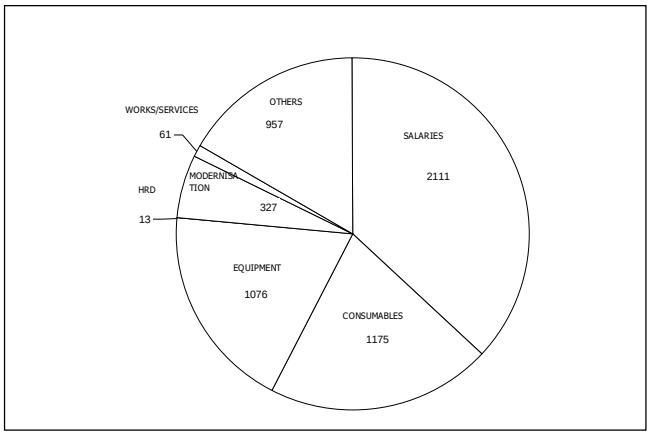
⇩ *Figure 15 Mr Justice Chidananda Ullal, Hon.Judge, High Court of Karnataka, delivering the Eighth Dr B R Ambedkar Lecture on the "Reservation policy and its evolution".*

⇧ *Figure 16 Dr Murli Manohar Joshi, the Union Minister for HRD, S&T and Ocean Development, and Vice President, CSIR, visited NAL on 30 May 2001.*

⇧ *Figure 17 The Parliamentary Committee on Science and Technology, Environment and Forests, led by Mr C Ramachandraiah, visited NAL on 16 Sep. 2000.*



⇧ *Figure 18 Rs 5001 lakhs were received from external sources during 2000-2001 (down by 8% from last year). The major contributors to this year's ECF were TDB (29%), AR&DB (21%) and ADA (19%).*



⇧ *Figure 19 NAL spent Rs 5720 lakhs on its R&D programmes in 2000-2001 (down 12% from the previous year). Salaries accounted for 37% of the expenses.*

STATISTICAL SUMMARY

The NAL staff strength as on 1 August 2001 was 1198. This includes 497 scientists (Group IV: 330 and Group III: 167), 500 in the technical cadre and 201 in the administrative cadre. 32 new sponsored projects (value: Rs 371.1 lakhs) and 14 new grant-in-aid projects (value: Rs 1759 lakhs) were taken up during 2000-2001. Our external cash flow (ECF) this year (*Figure 18*) was Rs 5001 lakhs, including Rs 1473 lakhs from the Technology Development Board (TDB) for the SARAS programme. The ECF has fallen marginally by about 8% after last year's all-time high of Rs 5429 lakhs. The major contributors to this year's ECF are the TDB (29%), AR&DB (21%) and ADA (19%).

NAL actually spent Rs 5720 lakhs (*Figure 19*) in 2000-2001 (down 12% from the previous year). 37% of this expenditure was for salaries, 21% for consumables and 19% for capital equipment.

HONOURS

It is finally a pleasure to mention the distinctions won by my NAL colleagues. Dr Shivakumara Swamy was elected a Fellow of the Indian National Academy of Engineering. Dr S Viswanath was the joint winner of the Dr Biren Roy Trust Award for the year 2000. Dr Rakesh Mohan Jha and Dr Sheela Ramasesha won the Sir C V Raman Award for their contributions to aerospace engineering and materials science respectively; Dr Sheela Ramasesha also won the 2001 MRSI Medal. Dr S K Saxena was selected as an International Member of AIAA's Thermophysical Technical Committee. Dr R M V G K Rao was admitted as a Life Member of the Instrument Society of India and Dr Harish Barshilia was chosen for the 2000 CSIR Young Scientist Award in Physical Sciences. I congratulate all of them.

Dr T S Prahlad
Director