History of HAL

A Pictorial Account




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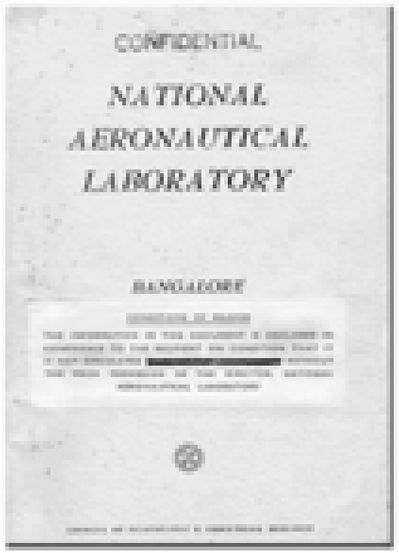
NAL in 1960

National Aeronautical Laboratory, now called National Aerospace Laboratories, was set up on 1 June 1959 with offices in Delhi and moved to Bangalore on 1 March 1960.

NAL opened with offices on Jayamahal Road (see photo) and Palace Road. The Jayamahal Road building was actually a stable of the Mysore Maharaja's palace!

The Mandate


CONFIDENTIAL

NATIONAL AERONAUTICAL LABORATORY

BANGALORE

a

NAL's mandate, spelt out in 1960, was the "scientific investigation of the problems of flight with a view to the practical application of the results to the design, construction and safe operation of aircraft".

A "confidential" document contained P Nilakantan's vision of NAL. NAL's first Director always kept this document locked in his personal custody.

NAL's first Director, P Nilakantan, held office from 1 June 1959 to 18 April 1964.

b

NAL's Palace Road office was also Nilakantan's residence.

Building a Campus

a

Work started quickly to create a proper infrastructure of buildings and facilities for NAL. NAL's first major project was to be the establishment of a wind tunnel centre (WTC).

M S Thacker, DG-CSIR, laid the foundation stone of the WTC on 2 July 1961. While Thacker (left) appears pleased, P Nilakantan (right) appears well aware of the enormity of the task ahead of him.

While the Belur campus, next to the HAL runway and the Bellandur lake, was chosen to house the WTC, two buildings to house the Technology Block and the Administrative Block were to be built on the Kodihalli campus, 5 km away, and closer to the city.

T K Narasimhachar, Nilakantan's secretary and A K Phalgunan (left), his chauffeur, pose in front of the proposed site of the Kodihalli campus.

b

Getting Started

The initial activity was focused on construction work at the Belur campus. To speed things up, the Army was requested to send bulldozers to level the ground.

Y V G Acharya (left) walks with Thacker and P Nilakantan for the foundation stone laying ceremony at Belur in 1961.

a

b

On the Kodihalli campus, work started for the construction of a Technology Block to house the Materials and Structures Divisions.

Ever impatient, P Nilakantan is ready with his axe to start the Technology Block construction activity. K G Katwey, NAL's civil engineer, invites the Director to start the operations. (1962?)

The UNSF story

a

In 1959, CSIR approached the United Nations Special Fund (UNSF) to aid the wind tunnel project. UNSF, partly due to international pressure, agreed only to fund the 1-ft tunnel project for $1,438,700 — and not the proposed 4-ft tunnel project.

P Nilakantan and S P Venkiteshwaran with the UNSF and ICAO experts.

b

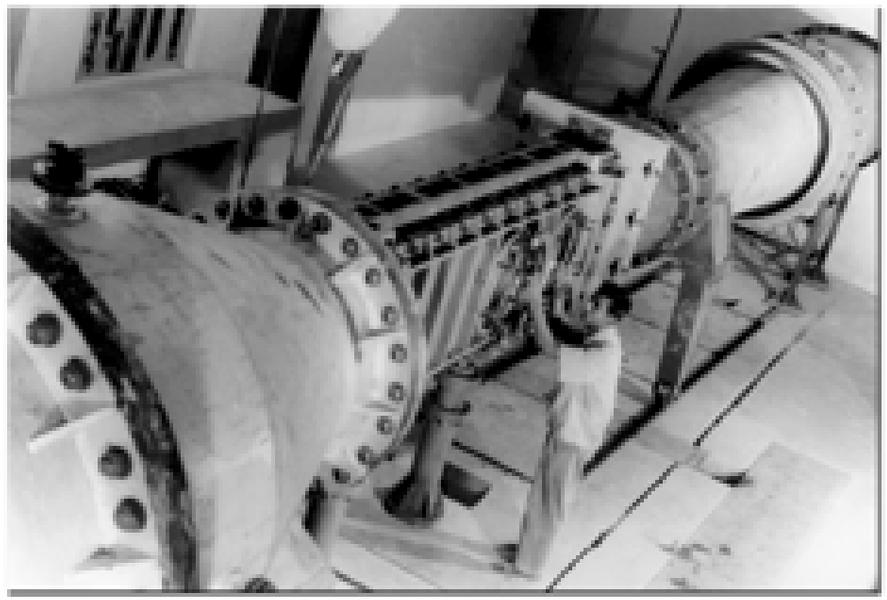
The UNSF inspector records her observations during her visit to NAL in 1962-63. Seen, from left to right, are S P Venkiteshwaran, M A Ramaswamy, H C Seetharam and P Nilakantan.

The Campaign

a

A prototype 2" x 2" intermittent blowdown wind tunnel was first proposed to be built, along with the associated compressed air supply system.

P Nilakantan and M A Ramaswamy with visitors.



b

While the speedy establishment of the wind tunnel centre remained NAL's primary concern, Dr Nilakantan and his team were equally busy creating facilites, receiving visitors and undertaking several novel experiments.

The construction of the 1-ft tunnel picked up momentum around 1963.

c

K G Katwey, Civil Engineer and M G Thakar, Admin. Officer reviewing the progress on the Belur campus.

International Seminar

a

NAL organised a Seminar on Aeronautical Sciences starting 27 November 1961 which was attended by 15 international experts including M J Lighthill, then Director, RAE. This Seminar gave a wonderful international exposure to Nilakantan's young scientists at NAL.

M J Lighthill and other experts with Nilakantan.

60 papers on aviation meteorology, aircraft structures and materials, wind tunnel design and testing, aircraft propulsion etc. were presented.

His Highness Maharaja Sri Jayachamaraja Wadiyar (seated at the right), Governor of Mysore, inaugurated the Seminar. M S Thacker, DG-CSIR, welcomed the participants.

b

Constitution of Executive Council

To advise NAL, CSIR constituted an Executive Council (EC), chaired by J R D Tata. Other members of the EC were Husain Zaheer, DG-CSIR, R N Kathju, V M Ghatage, Satish Dhawan, Vikram Sarabhai, S Bhagavantam, Arjan Singh and P Nilakantan. The EC first met on 28 March 1963.

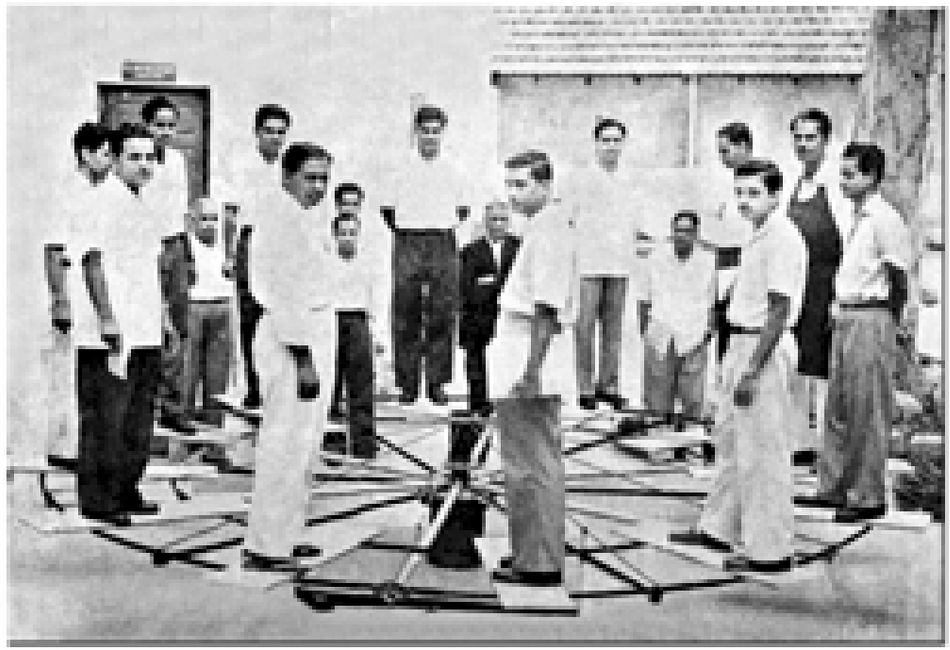
JRD chairing at 1965 EC meeting. Seen on JRD's right are Satish Dhawan (black suit) and V M Ghatage (lighting yet another cigar).

Wind Power

a

Wind power was an important facet of NAL's activity in its early years.

P Nilakantan and Mr S P Venkiteshwaran show a windmill to a foreign expert, possibly E W Golding of UK, in 1961.



b

Testing techniques were sometimes unusual.

Reinforced rotor of WP-2 windmill subjected to load testing in 1962-63.

Scientific Interactions

An unusually large number of visitors — many from outside India — made it to NAL in its early years, when international travel was quite uncommon. These visitors often delivered special lectures.

a

E W Golding at NAL. He delivered a series of lectures on "Problems of Wind Power" in 1961.

b

P Nilakantan holding a discussion next to the 2" x 2" prototype wind tunnel. Also seen, from left to right, are K G Katwey, M G Thakar, M A Ramaswamy and V Y G Acharya.

Creating the Core

a

Shortly after moving into Bangalore in 1960, Nilakantan contacted every engineering college in the city for information about their "best outgoing students" – and promptly offered the young students positions at NAL.

The Nilakantan team, with a visitor. Seen are S P Venkiteshwaran (extreme left), V Y G Acharya (fourth from left), M G Thakar (sixth from left). Also seen (extreme right) is a youthful D M Rao who played a leading role in NAL's wind tunnel projects.

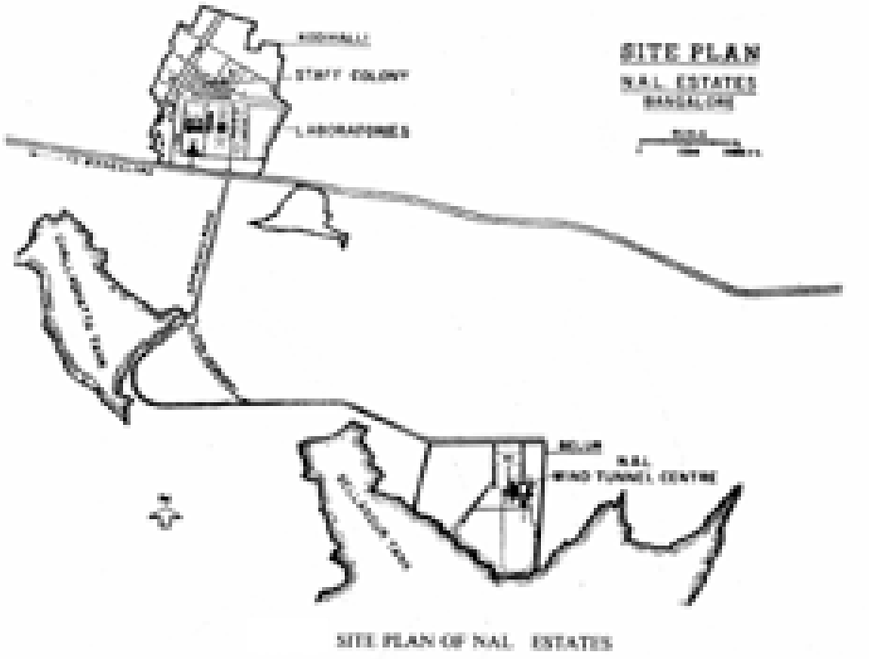
b

At the get-together to bid farewell to T K Narasimhachar, Nilakantan's overworked secretary, are (sitting L to R): B V Srinivasa Rao, B G Suryanarayana, T K Narasimhachar, M V V Murthy, B R Somashekar. (Standing L to R): N Nanjundaiah, M L R Murthy, Ningaiah, Narahari Achar, Sridhara Murthy, B R K Iyengar, Venkataraman, B J Amruthraj.

The Evolving NAL Campus

Around 1963, two blocks, to house wind tunnel activity, at Belur and one block, to house activity in materials and structures, were being constructed at a frenetic pace. Nilakantan's team was straining every sinew, although Nilakantan himself now appeared to be ailing.

Handing over of the first of the two Belur blocks.



SITE PLAN OF NAL ESTATES

Nilakantan Passes Away

P Nilakantan, NAL's first Director, passed away on 18 April 1964 in Coimbatore. At this point, NAL's wind tunnel projects were precariously poised: the 1 ft tunnel project was progressing well, and, on 8 April 1964, NAL signed a contract agreement with Canadian Vickers for setting up a 4 ft trisonic tunnel at an estimated cost of Rs 2.2 crores.

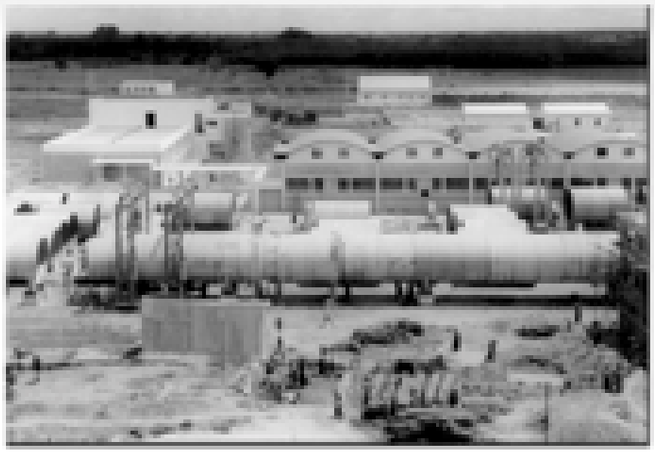
Nilakantan, looking decidedly unwell, at a EC meeting on 19 March 1964. Also seen are J R D Tata, S Husain Zaheer, S Bhagavantam and others.

4 ft Tunnel Project Starts

K G Krishnamurthi, Technical Secretary, CSIR, assumed charge of NAL as Officer on Special Duty (OSD) on 15 May 1964. The big action was now shifting towards the 4 ft tunnel project.

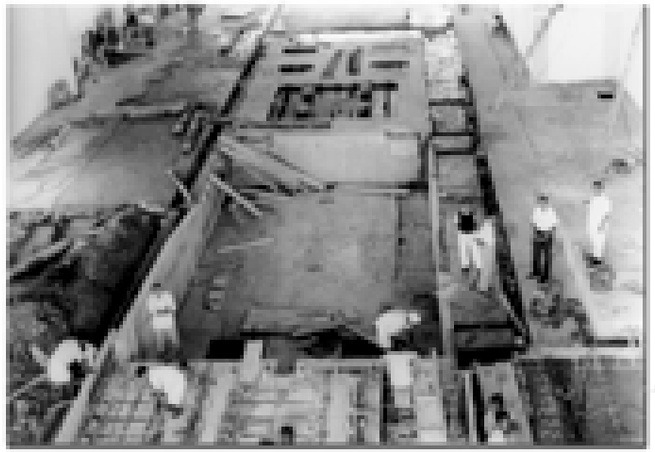
M C Chagla, Union Minister of Education and Vice President, CSIR, turning the first sod for the foundation of the 4 ft tunnel on 11 July 1964.

Mounting activity



a

b



c

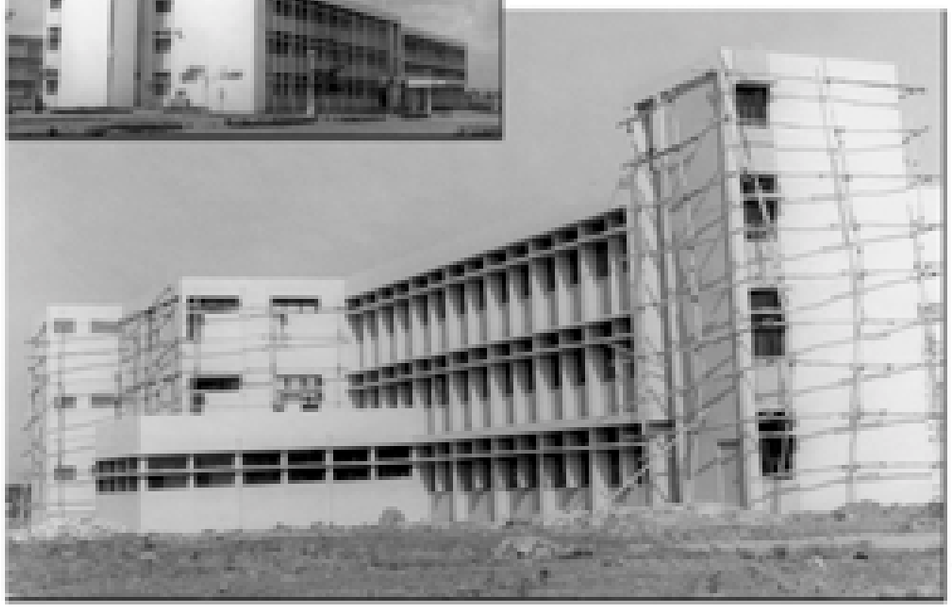
Work on the wind tunnels and the related equipment, instrumentation and control systems picked up momentum in 1965. The compressed air supply system, the air storage system and the compressed air ducting system were practically ready.

Construction of the 4 ft tunnel in progress.

Kodihalli Campus Takes Shape

The Technology Block, to house the Materials and Structures Divisions, was ready around 1965. About a year and a half later, the new Administrative Block, to house the Director's Office, the administrative machinery and the library was also ready.

A panoramic view of the Technology Block.



b

a

Two views of the Admin Block under construction.

Distinguished Visitors

a

A striking feature of K G Krishnamurthi's tenure was that a very large number of political leaders, bureaucrats and science managers visited NAL.

Atma Ram, Director-General, CSIR at the wind tunnel centre.

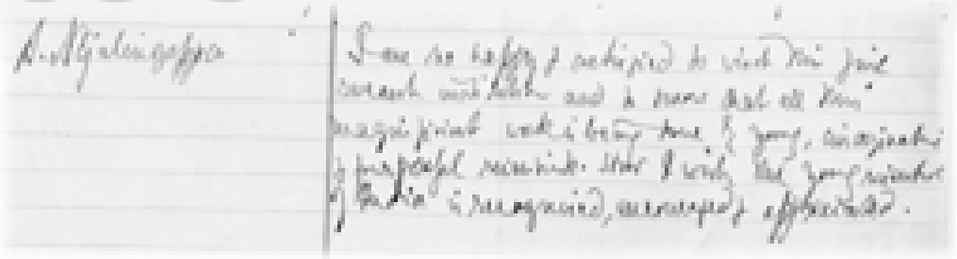
b

Air Vice Marshal P C Lal, then the Vice Chief of the Air Staff, with S Krishnan and K G Krishnamurthi. 1965.

c

Homi Bhabha signs the NAL visitor's book on 21 October 1965 as Vikram Sarabhai looks on.

More Distinguished Visitors

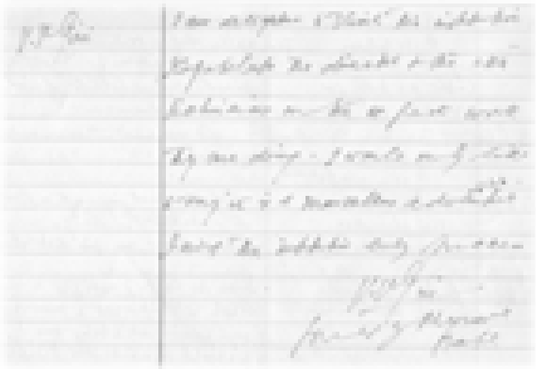


Visit of S Nijalingappa, Chief Minister of Mysore on 19 August 1965.

a

Visit of V V Giri, former President of India, and then Governor of Mysore, on 25 August 1965.

b



The Coming of S R Valluri

On 23 November 1965, S R Valluri, then only 41 years old, assumed charge as Director, NAL.

Valluri explains a point to S Chandrasekhar, then a professor at Chicago. Also seen on the right is S Ramaseshan, who joined NAL in October 1966.

4 ft Tunnel Campaign

Valluri was required to make sure that the momentum of the 4 ft tunnel project did not wane. "I only had a small role to play here", he recalls, "because Nilakantan had set everything up beautifully".

a

With A M Thomas (?), Minister of Defence Production at the 4 ft tunnel site on 13 June 1966.

b

The 4 ft tunnel nearing completion in 1966.

Spreading the Wings

a

NAL's activity started diversifying around 1966. The Structures and Materials Divisions were strengthened, and the Propulsion Division was formally created. The Systems groups continued their thrust on measurement and instrumentation.

A 1967 model showing NAL's expansion plans. N R Subramanian is seen at extreme left.

b

S R Valluri with Sher Singh, Deputy Minister for Education in the System Lab in 1967. S Krishnan and C S Rangan are also seen.

CSIR's Directors' Conference

NAL hosted the CSIR Directors' Conference for the first time in July 1966.

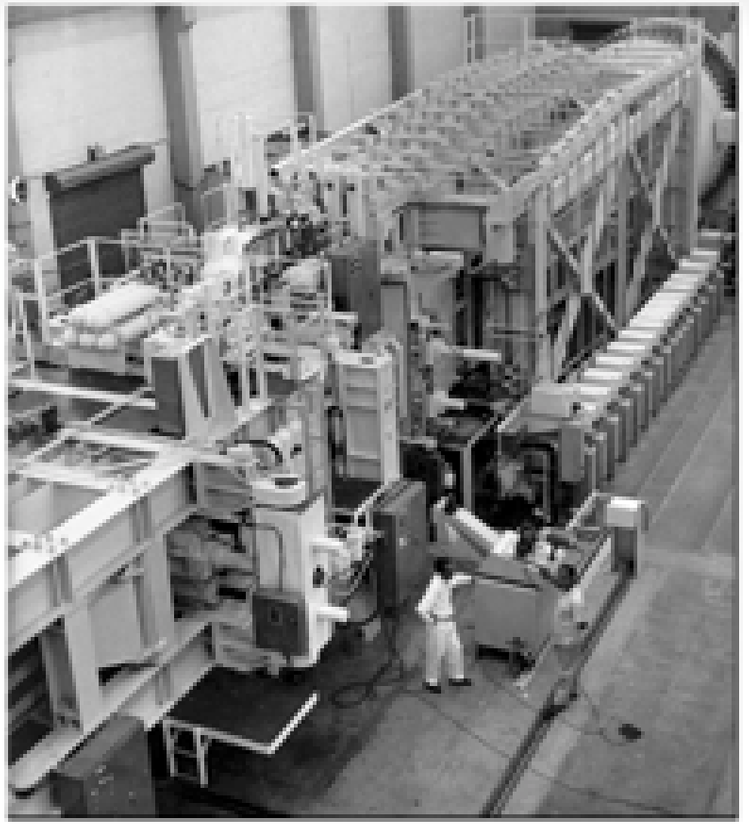
a

S R Valluri speaking at the CSIR Directors' Conference which was inaugurated by M C Chagla. Chagla also laid the foundation stone of the Systems Block.

b

Deliberations during the CSIR Directors' Conference.

First Blowdown



a

After three exhilarating years of engineering, the 4 ft trisonic tunnel was ready. When the roar of its first blowdown reverberated across the Belur Campus and the Bellandur Lake on 29 May 1967, it was a very special moment.

The 4 ft trisonic tunnel ready for its first blowdown.

An external view of the wind tunnel complex with the serene and full Bellandur Lake in the background.

b

Consolidation

With the completion of NAL's major facilities, the tempo of activities rose. A conscious effort was made to increase NAL's links with other national establishments such as HAL and GTRE.

Atma Ram, DG-CSIR, speaking at a NAL function. Seated on either side of the speaker are V M Ghatage and S R Valluri.

a

b

NAL's technical and managerial infrastructure was also enhanced. The Model shop fine tuned its model making skills; the Library's collections grew and NAL became the first CSIR lab to introduce project accounting.

Vikram Sarabhai at the Model Shop in the late 1960's.

Limelight

a

In the late 1960's it wasn't evident that aeronautics in India was heading for an unusually quiet decade or two. At NAL the mood was upbeat, as Valluri continued his crusade "to lay strong foundations for research in aeronautics bearing in mind the long term requirements of the country".

With C Subramaniam, Chairman Aeronautics Committee, Raj Mahindra, P A Paranjpe and others at the wind tunnel.

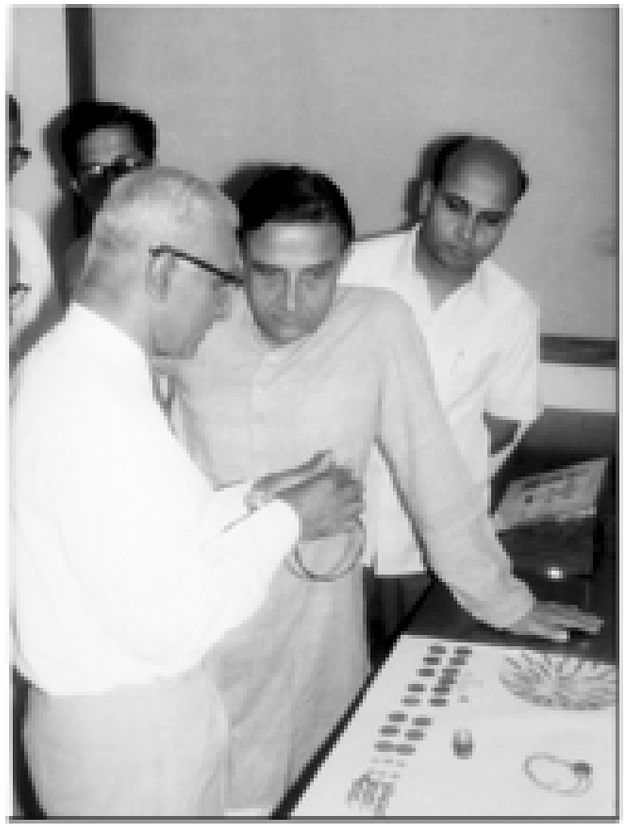
S Nijalingappa, Chief Minister of Mysore, visited NAL again on 24 May 1969. Another MP also visited NAL on 25 September 1969 and signed his name in The Visitor's Book.

b

Vikram Sarabhai

At the Materials Science Division with S Ramaseshan.

a

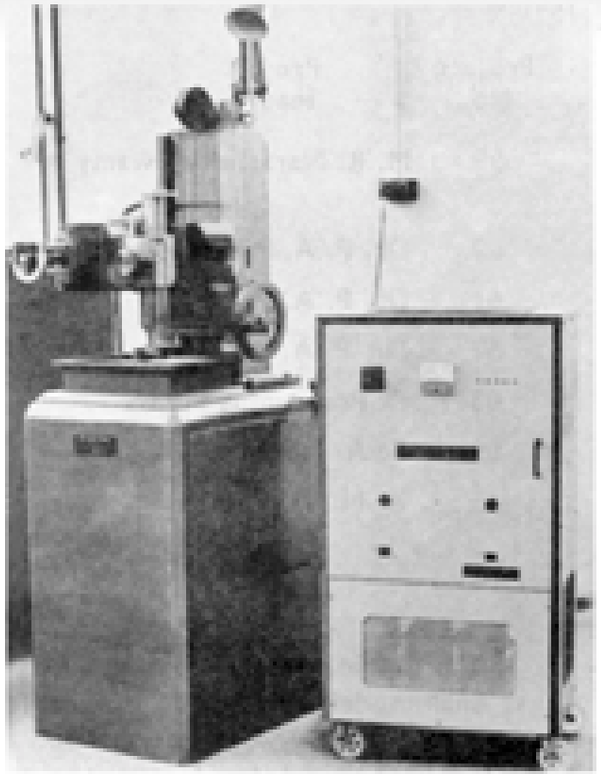


b

Vikram Sarabhai, who was a member of NAL's Executive Council from its inception, was a frequent visitor to NAL.

At the Instrumentation Division with C S Rangan.

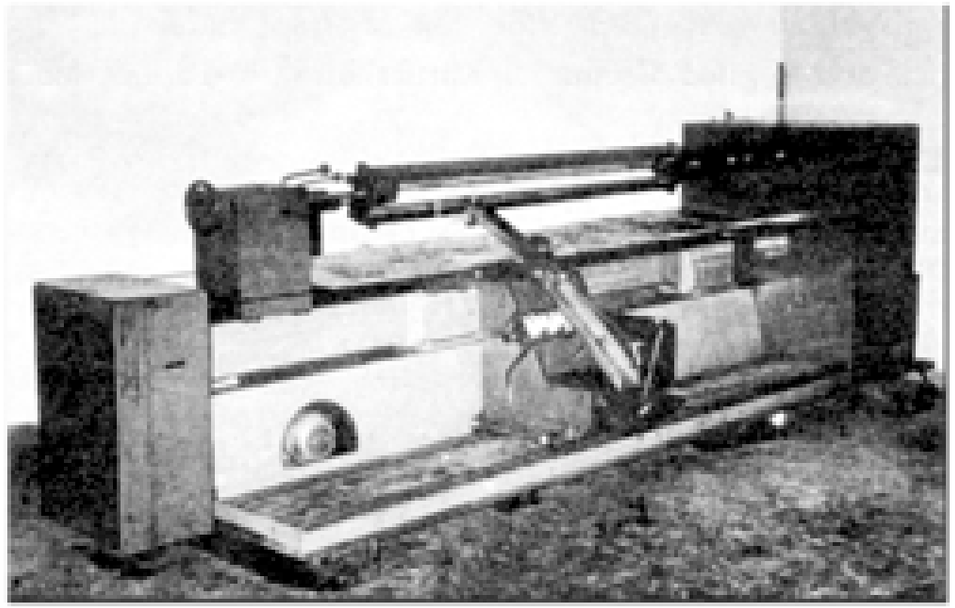
Early Technology Forays



a

In the late 1960's, the first attempts at technology development were initiated in several R&D divisions. Two projects in the Materials Science Division: on the development of a spark erosion machine and a filament winding machine were the precursors to greater success in the 1970's.

Spark erosion machine.



b

The filament winding machine designed around 1969 was capable of winding cylinders with a diameter of 6 cm and length of 220 cm.

Pilot Plants

The pilot plant was seen as the ideal interface to convert laboratory-scale R&D knowhow to the industrial scale. In the 1960's, NAL ran two pilot plants: on electrical transducers and associated measuring instruments and on digital systems. These plants were rather successful and also brought in a significant revenue.

Load cells manufactured at NAL pilot plants in the 1960's and 1970's.

Experimental Facilities

The early years of the Propulsion Division, which received a major fillip with the arrival of P A Paranjpe in end - 1966, were mainly involved in the design and fabrication of experimental facilities for cascade and ejector studies and a hot gas generation system.

P A Paranjpe (extreme left), Venkatesha Murthy and others at the Propulsion Division.

Special Individuals

Every Laboratory has its share of special or gifted individuals. M G Thakar, NAL's first Administrative Officer, served with unusual ability and dedication for well over a decade; R Narayana Iyer was considered to be an exceptionally gifted engineering service provider.

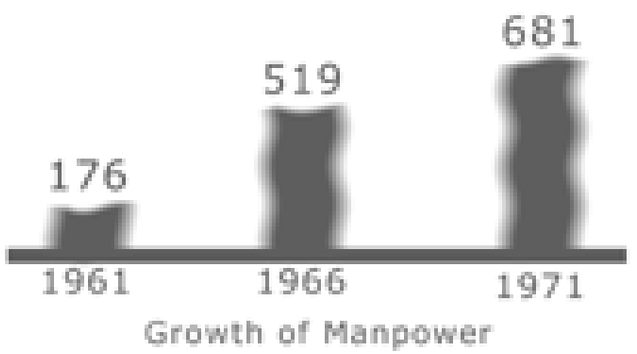
M G Thakar (left) at the Electronics Lab.

a

b

R Narayana Iyer (right) with the Secretary of the Royal Society, R V Ramani and Thakar. Narayana Iyer retired in 1975.

Ushering in the 1970's



Growth of Manpower

As NAL entered the 1970's, the mood was very optimistic. Valluri had successfully completed his first phase of consolidation. The 1 ft and 4 ft tunnels were busy and productive. Most of the R&D divisions had young, capable and dynamic heads. The links with the other aeronautical establishments and sponsors were firm. R&D infrastructural facilities were growing with the capital investment totalling Rs. 6.8 crores. The funding was encouraging and NAL's manpower had grown as the laboratory went all out to recruit the best possible talent.

NAL's manpower grew practically fourfold in its first decade.

Dorothy Hodgkin at NAL

The 1964 Nobel Laureate in Chemistry, Dorothy Hodgkin visited NAL's Materials Science Division in 1970.

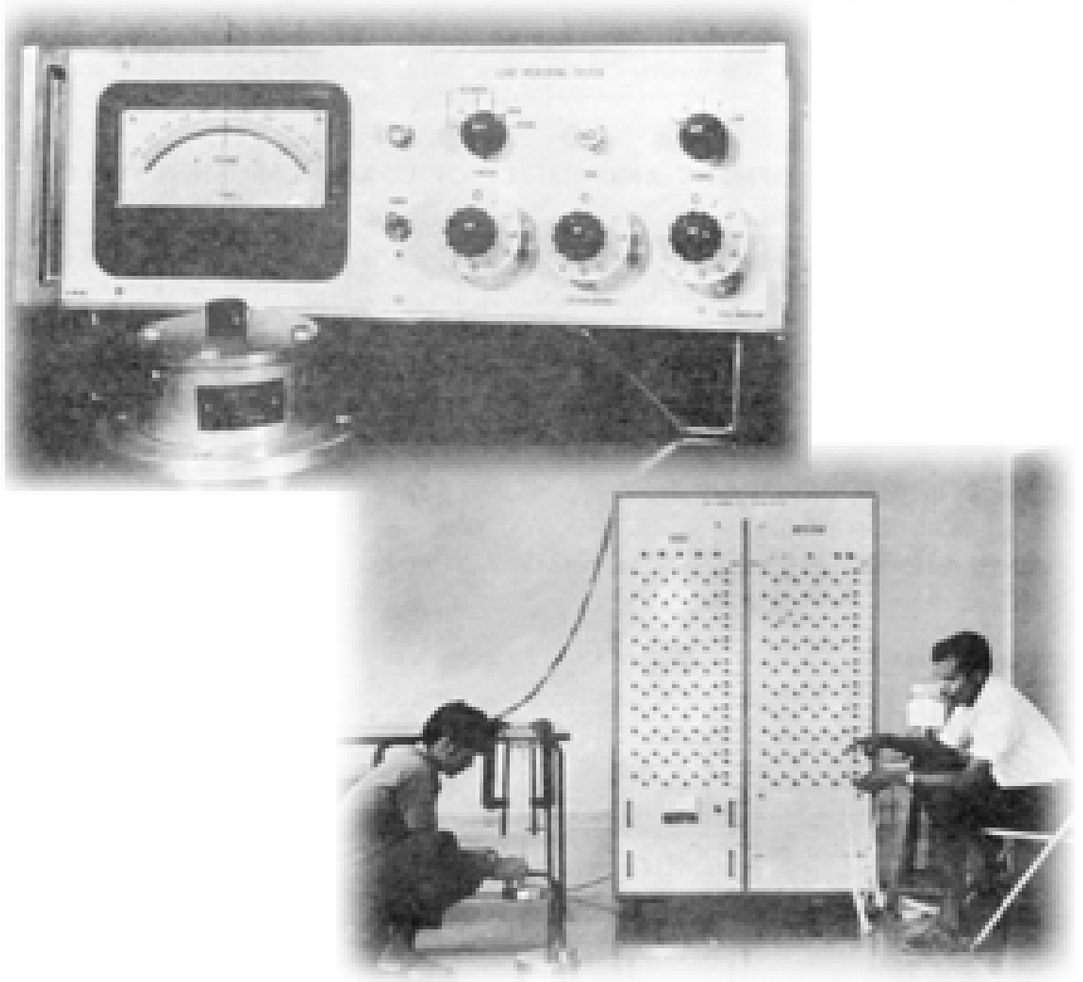
a

With Indira Rajagopal at the Materials Science Division Lab.

b

Another photograph with Indira Rajagopal. When Hodgkin visited NAL, Kalyani Vijayan — her only NAL student — was not present.

Digital Systems



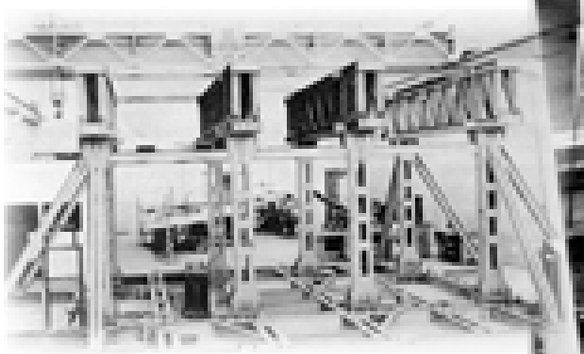
A very striking feature of NAL's activity, especially in the 1970's, is the amazing range and capability of digital equipment developed for various sponsors. Every annual report during this period has half a dozen photographs of data logging systems, load measuring systems, temperature controllers etc. which brought in typically 10-15% of NAL's revenue. It would also appear that most of them were for non-aeronautical applications.

A load measuring system and a 200-channel data logging system developed in 1970-71.

Fatigue Testing

One of NAL's finest engineering achievements in the 1970's was the development of a full scale fatigue test facility for testing fatigue life of aircraft - a problem of special concern to the IAF. Development work started in 1970-71 and the facility was commissioned in 1973.

Full scale fatigue test facility as it appears now.



Fatigue facility under construction in 1971.

Intellectual Ferment

It would appear that NAL was in the midst of unprecedented intellectual activity in the early 1970's. Interaction with academia and universities was very serious and a large number of professors, and the occasional Nobel Laureate, visited the NAL campuses.

P M S Blackett was at NAL on 13 April 1971, three years before the 1948 Nobel Laureate's death in 1974.

V S Arunachalam and S Ramaseshan with Prof Muller of Penn State University on 22 November 1972.

Changes in Delhi

Around 1971-72, C Subramaniam took over as Minister of Planning, Science & Technology – and consequently the Vice President of CSIR. Y Nayudamma took over as DG-CSIR.

C Subramaniam returns as CSIR's VP on 19 November 1971. He is seen here at Belur Model Shop.

a

b

Y Nayudamma, now DG-CSIR, visits NAL in 1972-73. He is seen talking to S R Valluri and S Ramaseshan.

J R D Tata

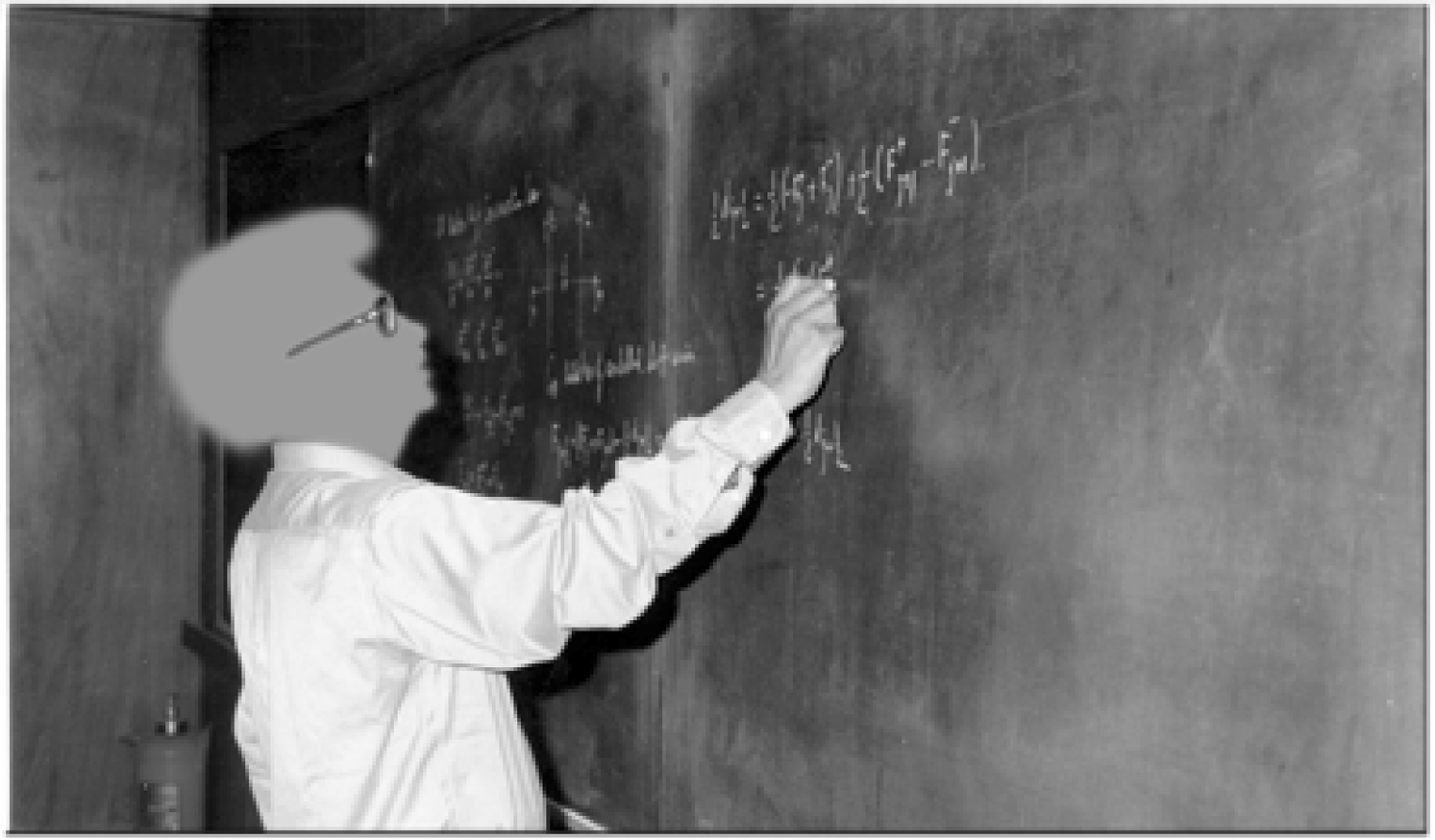
J R D Tata stepped down as the Chairman of NAL's Executive Council in 1973. We reproduce an extract from S R Valluri's tribute to JRD when he passed away in 1993.

"JRD stressed the need for striving for excellence in all things of consequence that happened in NAL. He came for the Executive Council meetings with meticulous preparation, with the agenda papers flagged and annotated, and with probing questions about the consequences of decisions requested of the Council. While he did so, he made it unmistakably clear that he was proud of his association with NAL. In discussions and private conversations, he always said 'our Laboratory' and never 'NAL'."

JRD, Ghatage and others talking to S Krishnan and his team at the Electronics Division in the mid-1960's.

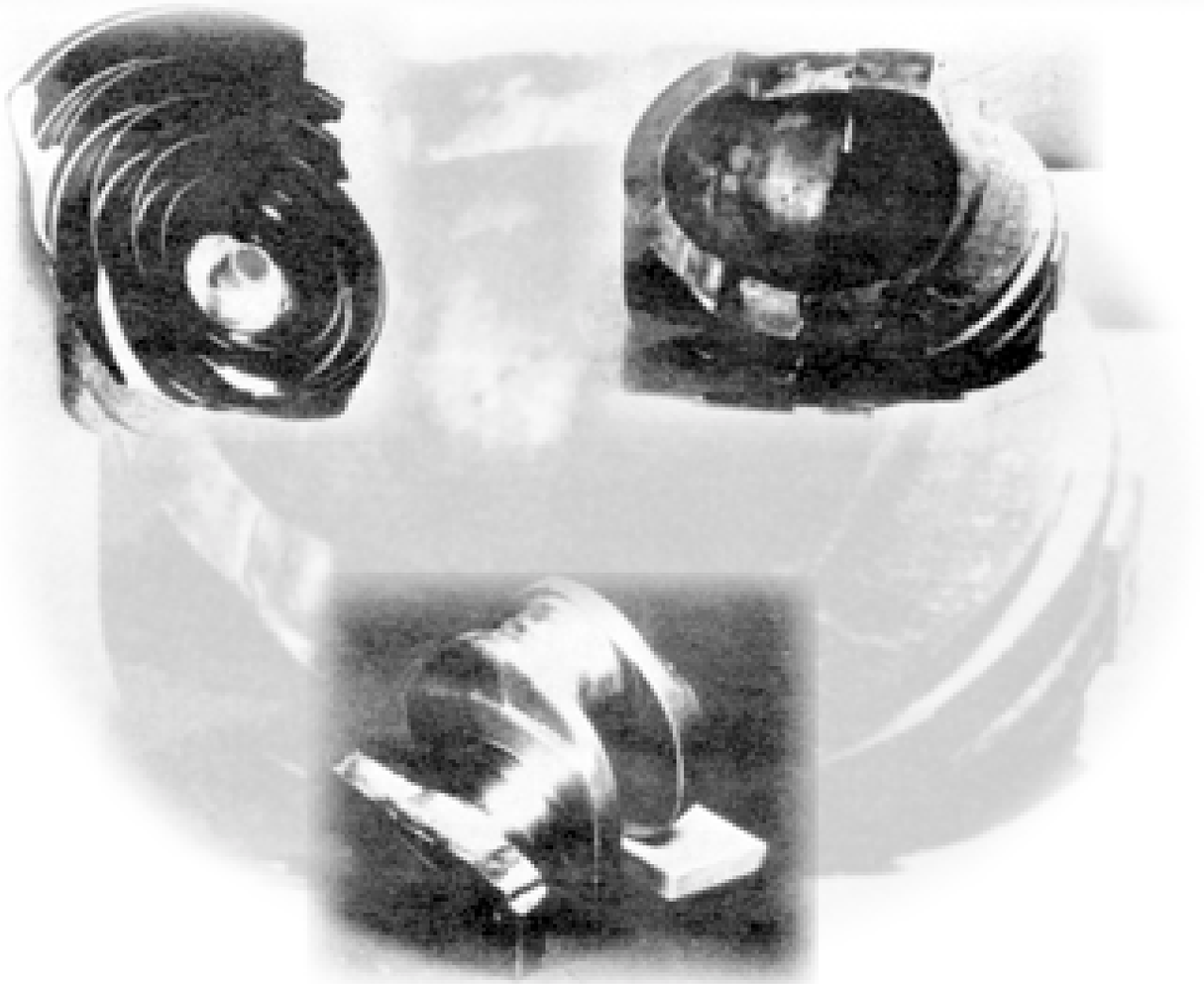
Power Cuts

The power cuts that followed the oil shock of 1974 affected NAL quite seriously; blowdowns at the wind tunnels, in particular, were severely disturbed. But this didn't hamper NAL's intellectual fervour. On the Belur Campus, S S Desai, P N Shankar and U N Sinha delivered a long course to young scientists on fluid mechanics (titled "FM-100").



A common sight at NAL in the mid-1970's.

Failure Analysis



In the early 1970's an exceptionally successful group on failure analysis and accident investigation evolved at the Materials Science Division. The group's investigations ranged from "components of a massive diesel generator to a seemingly insignificant bolt which led to a major accident".

Typical failures investigated at NAL in 1974-75.

Radomes

In 1971, the Materials Science Division created a fibre re-inforced plastic (FRP) pilot plant group to manufacture products for engineering applications. The earliest activity of the FRP Pilot Plant was to build large radomes to house sensitive electronic equipment.

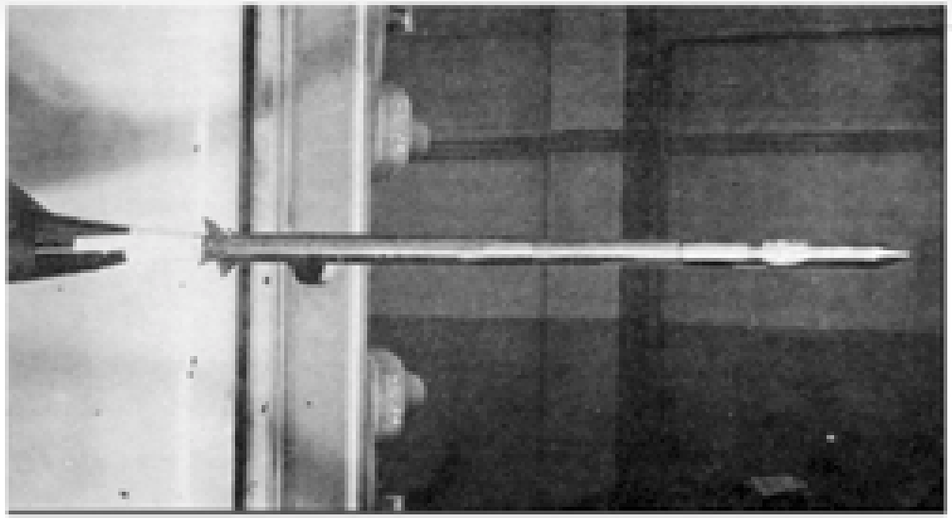
20 ft radome built in 1973.

a

b

This interesting photograph, taken in the mid-1970's, shows the radome coming up next to the current car park of the Kodihalli campus. Construction of the future Structural Integrity Division building, to house NAL's full scale fatigue testing programme, has just started. The area which now houses the Manipal Hospital and other hideous buildings is still a lush green site.

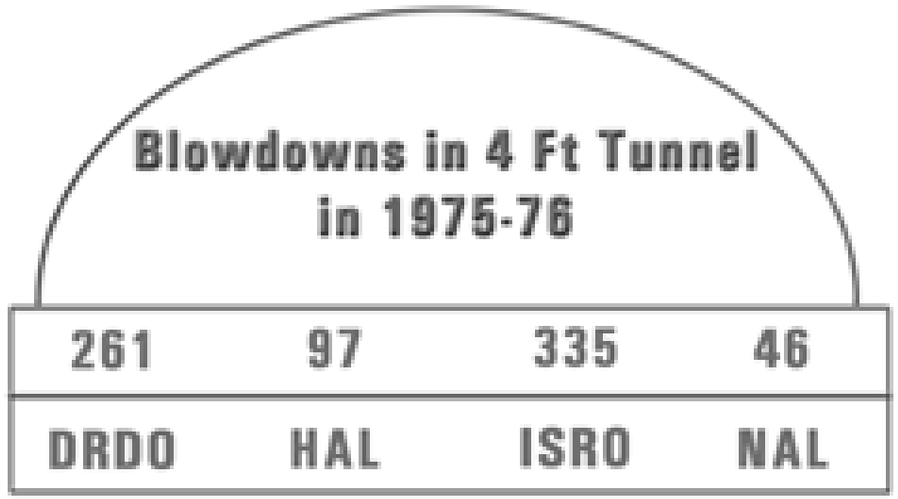
SLV-3 testing



a

ISRO first became a frequent user of the 4 ft tunnel when the launch vehicle projects started. A large number of blowdowns were conducted on a 1/20 scale SLV-3 model.

SLV-3 model in the NAL wind tunnel.



b

Utilisation statistics of the 4 ft tunnel in 1975-76.

"C is for Chromium"

This was the title of one of S Ramaseshan's lectures in the 1970's. In fact, there were several very interesting experiments undertaken during the mid-70's in the Division both on chromium and titanium formulations.

A happy moment at the Materials Science Division. Only R V Krishnan (second from left) doesn't appear amused. A K Rao is at the extreme right.

Steady Stream of Guests

a

The statistics of the 1970's list an unusually large number of guests and visitors to NAL. Now a splendidly equipped laboratory, NAL had much to show off.

Sir Alan Cottrell, Chief Scientific Adviser to the UK Cabinet with S R Valluri and M A Ramaswamy on 28 January 1972.

b

The Commonwealth Advisory Aeronautical Research Council (CAARC) executive delegates met at NAL on 5 February 1973. Here they meet S Nagabhushana at the Electronics Division.

Dhawan at NAL

By the mid-1970's Satish Dhawan was extremely busy – at ISRO and at IISc. His visits to NAL, therefore, were sadly infrequent. But it was always a special pleasure to meet him when he turned up for the occasional meeting or discussion. Only NAL scientists like Sridhara Murthy, P A Paranjpe and M Shivakumara Swamy, who were assisting Dhawan in the Avro investigation, were more fortunate.

Dhawan takes time out in May 1976 to visit the Materials Science Division.

10,000 blowdowns of 1 ft tunnel

Even as the power problems at the NAL wind tunnels eased, there was a wonderful moment to celebrate as the 1 ft tunnel, which started operations in 1966, completed 10,000 blowdowns.

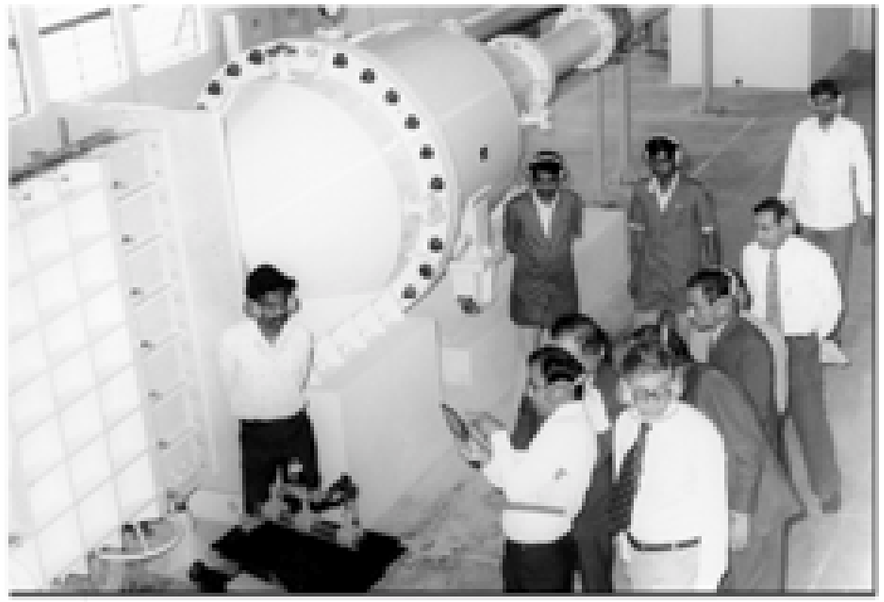
R Narasimha presses a button to initiate the 10,000th blowdown in September 1976. Also seen, partly, next to S R Valluri is K N Raju. V Kanagarajan appears especially delighted with the proceedings.

Advanced Experimental Facilities

a

Paranjpe before a UNDP press conference on 1 March 1979.

Right through the 1970's, the Propulsion Division continued to carry out applied research in turbomachinery and combustion. Advanced experimental facilities such as the high speed compressor test rig and the transonic cascade tunnel were set up.



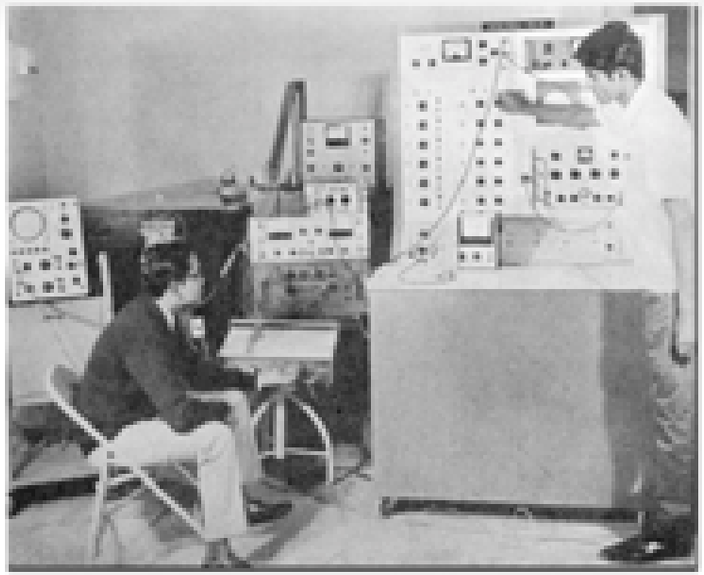
b

The UNDP team at the transonic cascade tunnel (TCT) in 1979. Seen wearing ear protection plugs are B K Chandrappa (left) M S Ramachandra (Centre) and P A Paranjpe. Sound levels at TCT then ranged between 110-135 dB.

c

H E Lubomir Strougal, Prime Minister of Czechoslovakia visits the Propulsion Division on 6 December 1974.

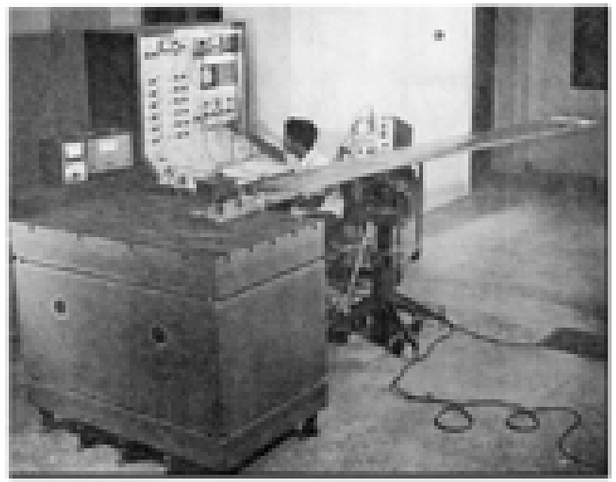
Vibration Testing



a

The fields of activity during the 1970's in the Structural Sciences Division included aircraft vibration and aeroelasticity, aircraft structural mechanics, computer-oriented structural analysis and composite structures. Projects involving vibration testing began in the early 1970's itself with vibration tests on typical aircraft wings and a typical fullscale helicopter rotor blade.

Vibration test in progress monitored by R Balasubramaniam.



A helicopter rotor blade undergoing vibration testing.

b

SED = Instr + Elect + Math. Sci

Instrumentation
+
Electronics
+
Mathematical
Sciences
=
Systems Engineering

In 1977-78, NAL created a new division called the Systems Engineering Division (SED) which merged the erstwhile Instrumentation, Electronics and Mathematical Sciences Divisions "to respond to the rapidly growing linkages and to expand to activities conducive to the development of large systems". C S Rangan was named the Head of SED.

A motion based simulator designed and built in the SED in the early 1970's for pilot dynamic studies.

Growing Ties with IAF

a

In the second half of the 1970's, NAL's interactions with the Indian Air Force grew by leaps and bounds. The full scale fatigue test facility offered a wonderful opportunity to extend the fatigue life of military aircraft in operation such as the Gnat and Ajeet. Valluri also proved to be a very forceful and convincing communicator of NAL's capability.

With Air Marshal I H Latif in 1979.

b

Valluri in an animated discussion with Air Marshal B W Chauhan as A C Raghuram, K N Raju and S Balakrishna look on.

Growing Interest in R&D Management

In 1976, NAL hosted a UNESCO Seminar on Management of R&D Institutions. It was a trifle unusual that NAL should host such a seminar. This was perhaps the first indicator of Valluri's — and NAL's — growing recognition of the importance of good R&D management.

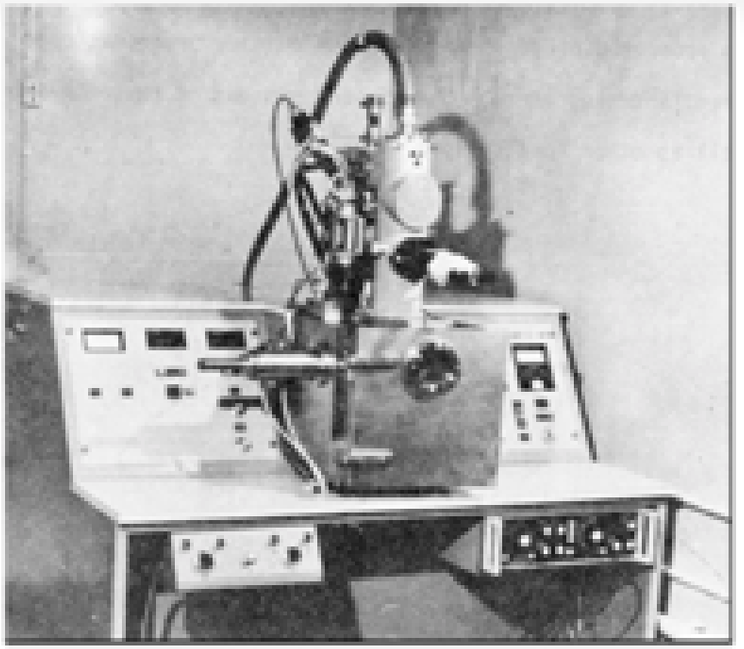
Inauguration of the Seminar on 1 August 1976. Valluri and P N Haksar can be seen seated on the dais. It would appear that R K Bera is proposing the vote of thanks.

a

b

Valluri with delegates of the UNESCO Seminar.

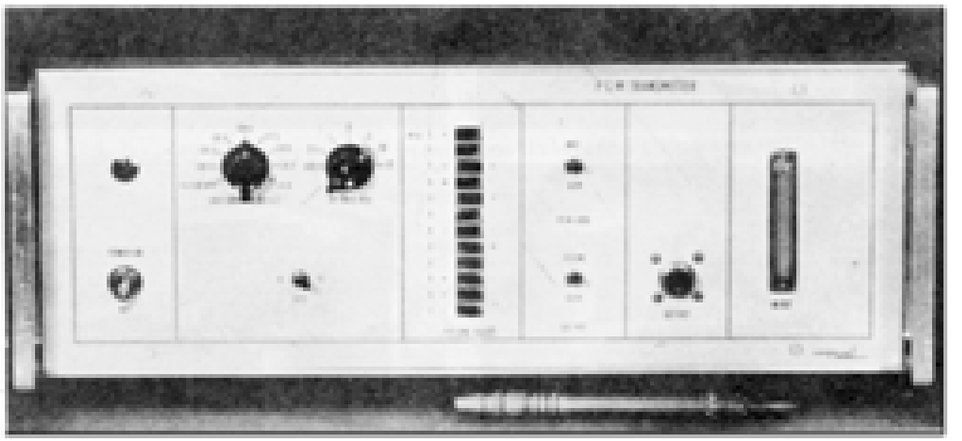
New Forays in Aerospace Electronics



a

The new Systems Engineering Division initiated a series of projects to guide its activities closer to the aerospace disciplines. A complete change-over to full-fledged aerospace applications would take a little longer.

A 2.4 kW electron beam welding facility was established to develop high quality transducers. This was to enable NAL to improve its range of pressure transducers, load cells etc. for their application in aerospace fields.



b

A PCM telemetry system was developed for transfer of remote data (e.g. from an aircraft) to a ground computer for analysis and displays.

Unusual Visitors

Leafing through NAL's collection of old photographs one sometimes sees faces of very unlikely visitors: e.g. T N Seshan and Veerappa Moily.

T N Seshan on a visit to NAL in the mid-1970's possibly at about the time when he was an Addl. Secretary at ISRO.

a

b

Veerappa Moily who was an invited guest at a CSIR-industry meet in 1977.

Two Air Crashes

a

The fatal accident to an Indian Airlines Caravelle aircraft, on 12 October 1976, drew NAL's failure analysis group into its first major aircraft accident investigation. The metallurgical investigation of the failure of the 10th stage compressor disc of the Avon engine contained several worrying pointers that were communicated to Rolls Royce.

The compressor disc in question.

The accident to the Boeing 737 aircraft at Meenambakkam Airport, Madras on 26 April 1979 — with mercifully no casualties — was due to an explosion in the aircraft's front toilet.

b

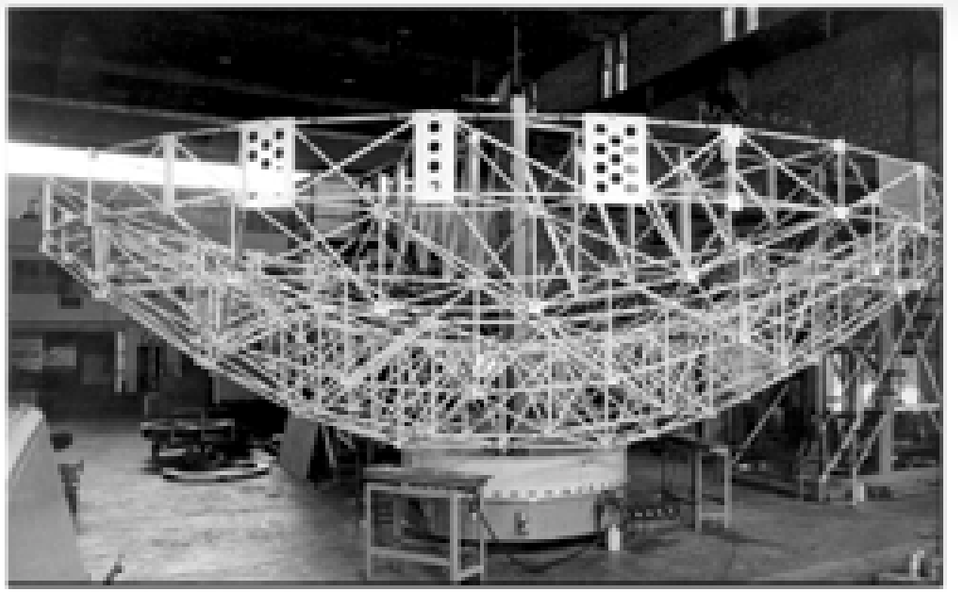
The damaged Boeing 737 aircraft.

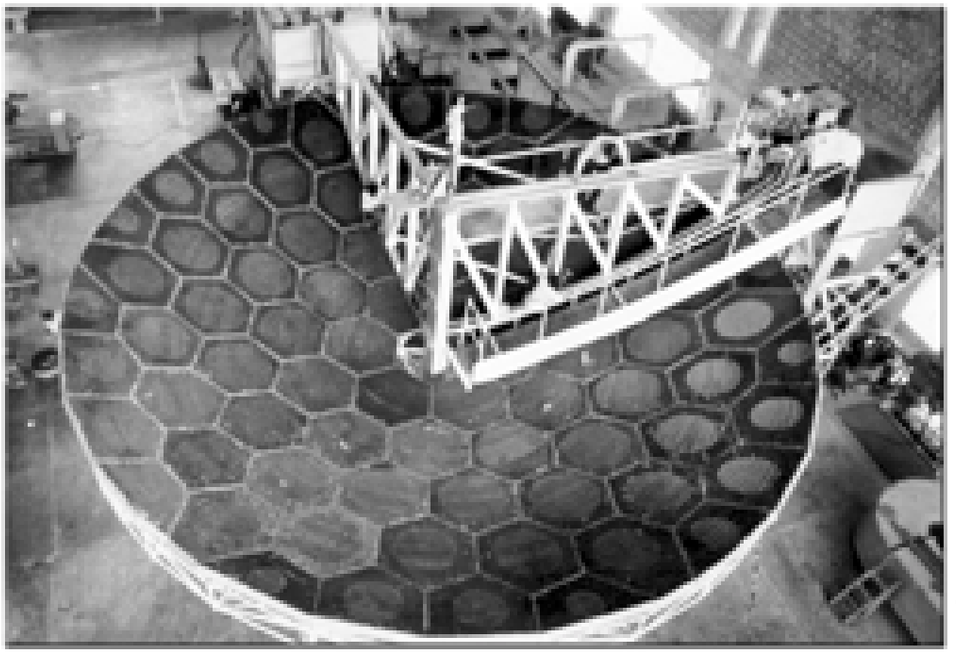
Radio Telescope

In an interesting exercise starting 1977-78, NAL collaborated with Raman Research Institute to fabricate at 10 m diameter radio telescope for millimeter wave length.

The project starts.

a





b

The telescope is almost ready.

Raja Ramanna's visit

a

Raja Ramanna, having taken over as the new Scientific Adviser to the Minister of Defence, paid an important visit to NAL in June 1979. His visit changed many perceptions and promised a new relationship between NAL and DRDO establishments.

Raja Ramanna with S R Valluri, PA Paranjpe and K S Yajnik (looking different with a moustache!) on the Belur Campus.

b

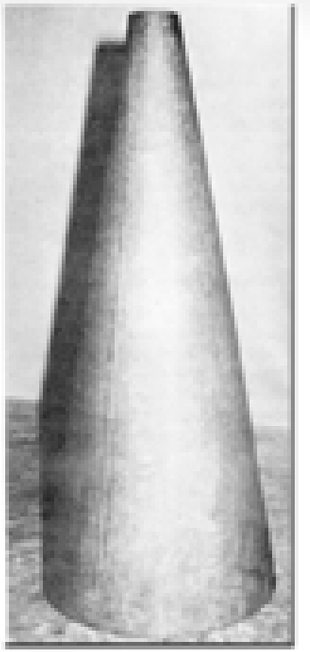
In conversation with V Sreedhara Murthy, S R Valluri, P A Paranjpe and K S Yajnik.

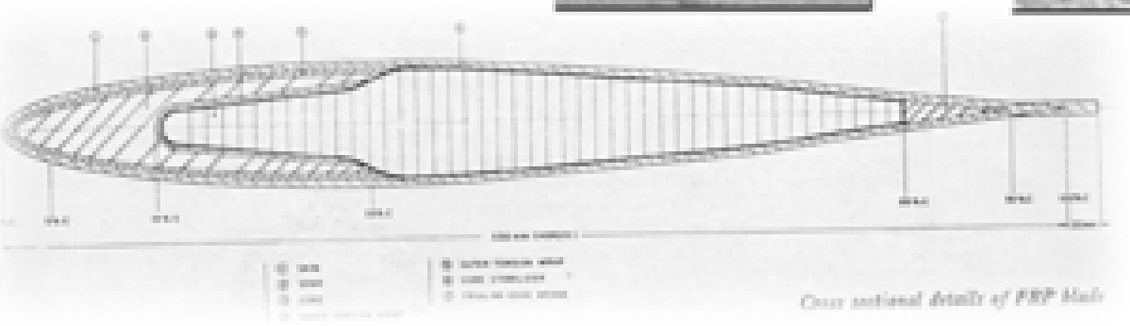
Enter Composites

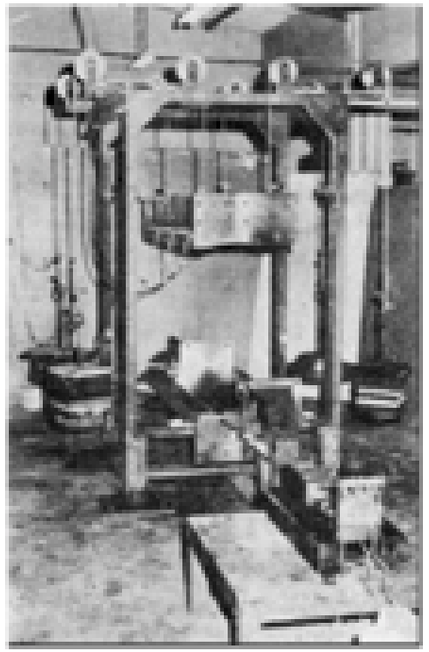
Although the FRP Pilot Plant built several composite products, the first initiatives to develop composite structures for *aerospace components* were visible by the end of the 1970's. Projects to develop a FRP helicopter blade and a composite nose cone were initiated.

Composite nose cone development.

a







b *FRP helicopter rotor blade development.*

CSIR's Directors' Conference Again

a

NAL hosted the CSIR Directors' Conference again in October 1979, this time in the NAL library building. M G K Menon had now taken over as CSIR's Director General.

Directors' Conference in Session.

b

M G K Menon with S R Valluri and Roddam Narasimha

Busy 1979

a

Sher Singh, Minister of State for Defence, Space and Atomic Energy visited NAL on 12 April 1979.

Looking back at the NAL archives, 1979 appears to have been an unusually busy year even by NAL standards. The 5-day International Conference on Fracture Mechanics in Engineering Applications, held during 26-30 March 1979 featured 200 participants, including 40 from outside India.

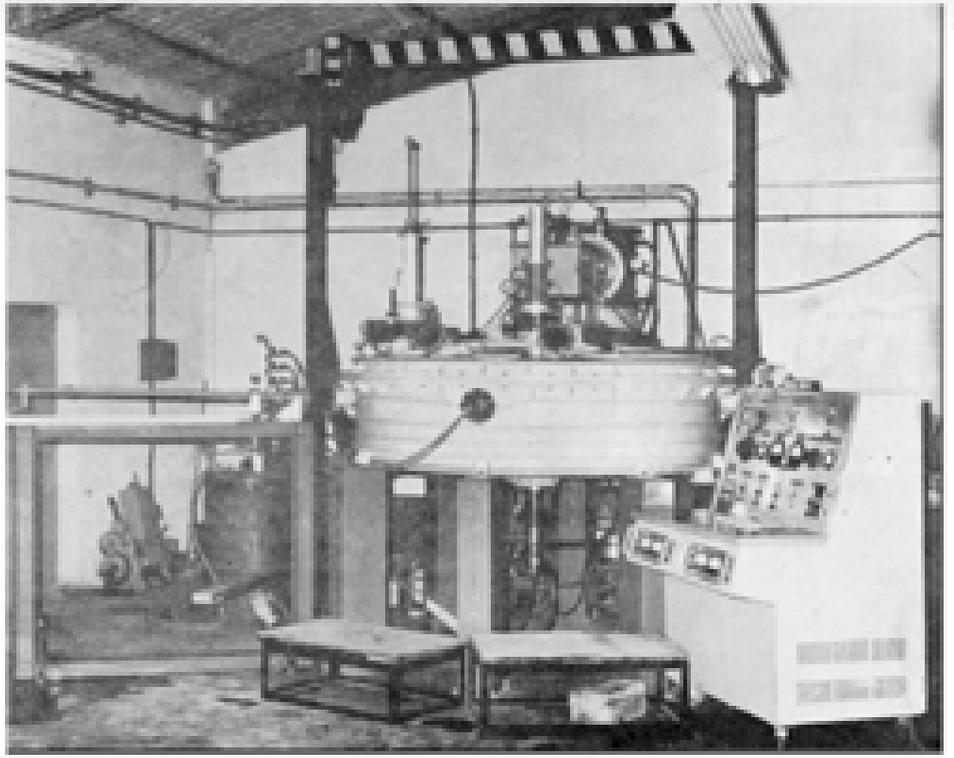
b

Satish Dhawan inaugurated the conference. His address strongly articulated the view that science must benefit society.

c

Visitors to the Systems Engineering Division. S Balakrishna (left) and C S Rangan are also seen.

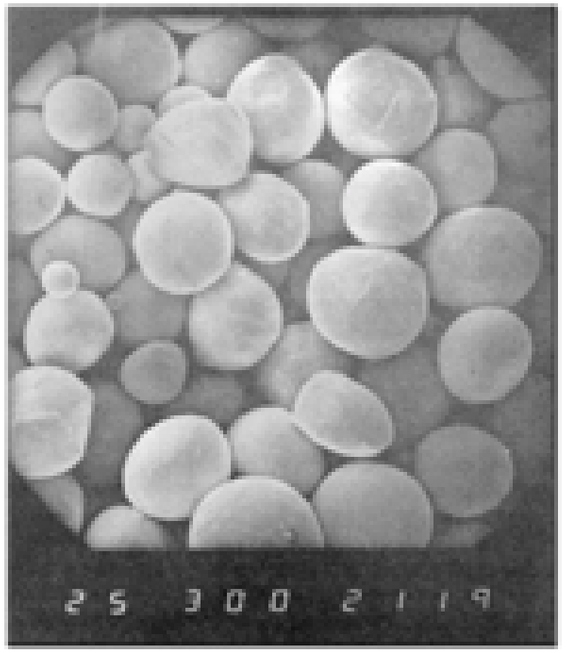
Powder Metallurgy



a

An outstanding NAL success as the decade of the 1970's ended was the development of a 2 m diameter stainless steel atomisation chamber for the production of titanium alloy powders. With 17% of the world's titanium reserves in India, this was a very promising initiative.

The 2 m dia stainless steel vacuum atomisation chamber.



b

Titanium alloy powder produced at NAL using the rotating rod process (RRP).

70's Miscellany

Three photographs to give a typical flavour of events in the 1970's, and of the gentlemen who contributed to NAL's fortunes during the decade.

a

S R Valluri and B R Somashekar with P N Haksar in the Structures Division.

b

S Ramaseshan, Raj Mahindra, P N Murthy and U R Rao at a get-together. Satish Dhawan can also be spotted in the background.

c

L Ramanathan (right) at a party. Ramanathan was NAL's administrative officer through the 1970's and was known to be a very upright, capable and conscientious officer.

"A beautiful bride, all decked up"

NAL's gleaming Administrative Block.

a

As the 1970's drew to a close, NAL, more than ever before, looked like "a beautiful bride, all decked up, but with nowhere to go" (a remark attributed to Satish Dhawan). Valluri, who was honoured with a Padma Shri during the decade, seemed acutely conscious of this, and, indeed, was already actively involved in lobbying for a light combat aircraft development project in the 1980's, which could make use of NAL's wonderful capability.

b

NAL honours Valluri after he received the Padma Shri award.

The Systems Block

c

The View from the Top

This excellent photograph shows NAL's Kodihalli Campus around 1980. The Admin Block is now flanked by the (now called) T S Block and the Library Annexe. The System Block, arguably NAL's prettiest construction, is to the right. Behind the Admin Block one sees the Technology Block and, behind it, the SID building. Even the canteen is visible.

Engineering Workshops

NAL's workshops, well-equipped and with some extremely skilled engineers and operators, played exemplary supporting roles. In the 1970's and 1980's, NAL preferred a central workshop model.

A view of the workshop on the Kodihalli Campus.

Nurul Hasan's Visit

Every Minister of Science and Technology must have visited NAL. Such visits always made a big impression – and earned NAL valuable goodwill in Delhi.

S Nurul Hasan, S&T Minister and Vice President CSIR visited NAL on 1 July 1980. He is seen talking to M A Ramaswamy. L Ramanathan is at extreme right.

Satish Dhawan

In 1980, following the retirement of Air Marshal Dastur, Satish Dhawan was persuaded to become the Chairman of NAL's Research Advisory Council. It was the beginning of a truly marvellous association.

Satish Dhawan always had something interesting and valuable to say.

New Fatigue Testing Lab

A new facility for fatigue testing was inaugurated in 1981.

Air Marshal B W Chauhan inaugurated the facility in Air Marshal Latif's absence on 19 May 1981. Air Marshal Latif eventually visited the facility on 20 July 1981.

Right through the 1980's this facility was the venue for some truly amazing experiments in fatigue and fracture by K N Raju, R Sunder and the rest of the team. These experiments often involved very innovative use of hardware-software interfaces.

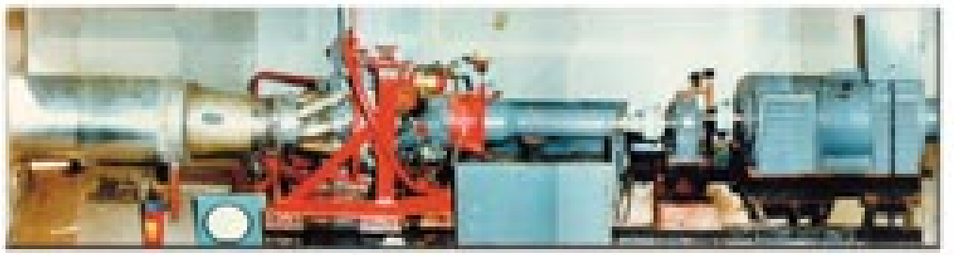
In 1987-88 a new materials evaluation lab with micro-processor based fatigue test controllers was set up as part of the facility.

Power from Sludge Gas

a

A time-expired Rolls Royce Dart engine was modified to burn sludge gas generated at the KC Valley of the Bangalore Water Supply and Sewerage Board. Early experiments in the 1980's demonstrated that about 800 kW was available through such a system.

A view of the experimental facility.



b

Gas turbine cogeneration plant operating on sludge gas.

Fifth ISABE

NAL organised the Fifth International Symposium on Air Breathing Engines (V ISABE) at Bangalore for the first time.

S R Valluri speaking at the V ISABE held in February 1981. Over 250 delegates participated in this symposium organised by P A Paranjpe and his team.

G S Sidhu's Visit

Shortly after taking over as CSIR's Director-General, G S Sidhu visited NAL in mid-1991.

With V Ramachandran and other colleagues in the Materials Science Division.

NAL-DLR Cooperation Starts

On 30 January 1982, CSIR/NAL and the German Aerospace Centre (DLR; then called DFVLR) signed a cooperative agreement to promote joint effort and collaboration with special emphasis on civil applications in aerodynamics, structures, turbomachinery, systems and materials.

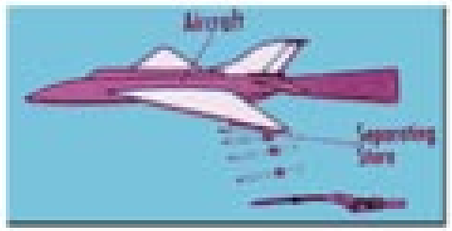
AVRA

An early AVRA prototype developed around 1980.

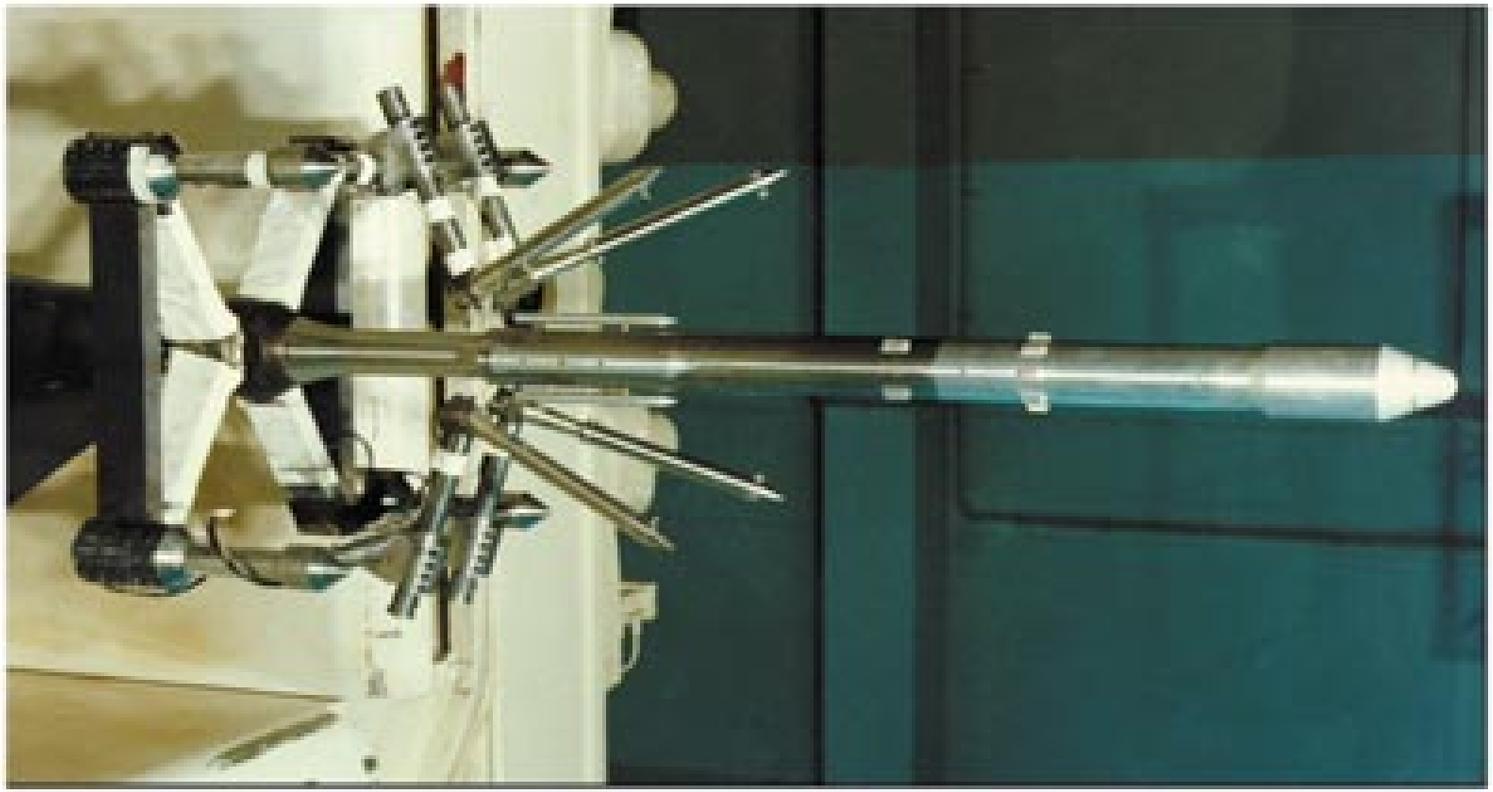
In the early 1980's, NAL developed the first prototype of the automatic visual range assessor (AVRA) to measure runway visibility. Later, an AVRA demonstrator was installed at Delhi airport and the technology was transferred to BEL.

AVRA installed at the Indira Gandhi International Airport in 1987.

Magic at the 4 ft Tunnel



Studies for separating store.



Rig for multi-booster separation studies.

NAL was often required to develop innovative techniques or designs for complex wind tunnel testing campaigns. The requirement to study the store separating from a fighter aircraft (first encountered in 1976) eventually led to the development of the semi-captive trajectory simulation technique. The multi-booster separation trajectory rig of the early 1980's allowed the wind tunnel simulation of four boosters simultaneously from the core PSLV vehicle.

10,000 blowdowns at 4 ft tunnel

The 10,001st blowdown of the 4 ft tunnel was initiated by Air Marshal L M Katre, then the Chairman of NAL on 4 August 1983. The utilization of the tunnel was shared between HAL, NAL, ISRO and DRDO based on a well-defined arrangement.

Air Marshal Katre presses the button.

CLOCTER

The closed circuit centrifugal compressor test rig (CLOCTER), established with UNDP assistance, was commissioned in 1983 at the Propulsion Division. This facility was set up for R&D investigations on different types of centrifugal compressors used in small gas turbine engines, industrial and multi-stage units, turbochargers and refrigeration units.

The CLOCTER facility as it looked in 1983.

A Full-fledged Computer Centre

Shivraj Patil speaking at the inaugural function.

NAL's Computer Centre was formally established on 1 April 1982 but the big moment came on 13 May 1984 when Shivraj Patil, Minister of State for S&T, declared open the new building housing the Sperry Univac 1100/60 computer and the AD/380 graphics computer.

Shivraj Patil declares open the Computer Centre.

S R Valluri Retires

S R Valluri retired as Director on 30 June 1984 after leading NAL with great distinction for almost 19 years. During his final years as Director, Valluri worked tirelessly for the Government's approval of a national light combat aircraft (LCA) project. The project was formally approved in July 1983 and Valluri was invited to be the Director-General of the Aeronautical Development Agency (ADA), the apex body to manage the LCA programme.

Extracts from the NAL Director's report during 1981-82, 1982-83, 1983-84, indicating NAL's important role in the LCA initiative.

The Belur Campus

A first day cover issued in 1984 to mark 25 years of NAL.

Following S R Valluri's retirement, P A Paranjpe, Head, Propulsion Division, took charge as Acting Director, NAL, on 1 July 1984. NAL also completed its first 25 years in 1984. The Laboratory was now pretty and well-equipped – and ready for new challenges.

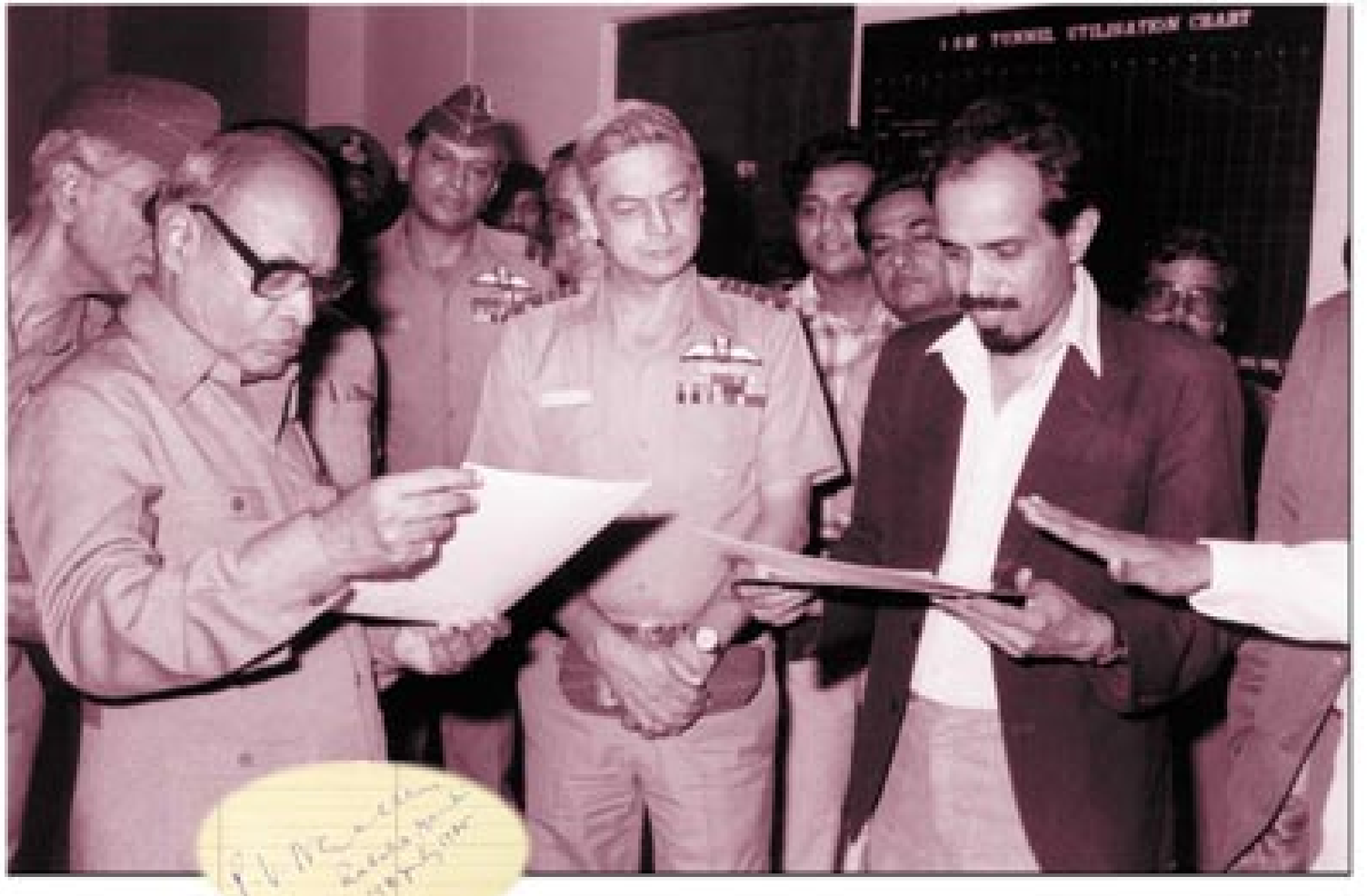
The Belur Campus as it appeared around 1984. Then, as indeed now, this is an exceptionally pretty campus.

R Narasimha is NAL's Third Director

Roddam Narasimha, Professor, Department of Aerospace Engineering, Indian Institute of Science, assumed charge as NAL's third Director on 19 October 1984.

With P V Narasinha Rao, Defence Minister in 1995.

Getting Ready for the LCA

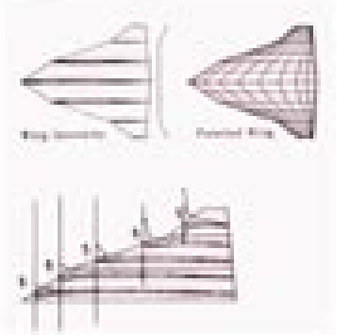


P V Narasimha Rao seeing some aircraft models at NAL.

One of Narasimha's first tasks as NAL Director was to streamline NAL's interface with the ADA and plan the Laboratory's response to the LCA challenge.

With the Defence Minister and Air Marshal M S D Wollen, Chairman of HAL.

SOFFTS

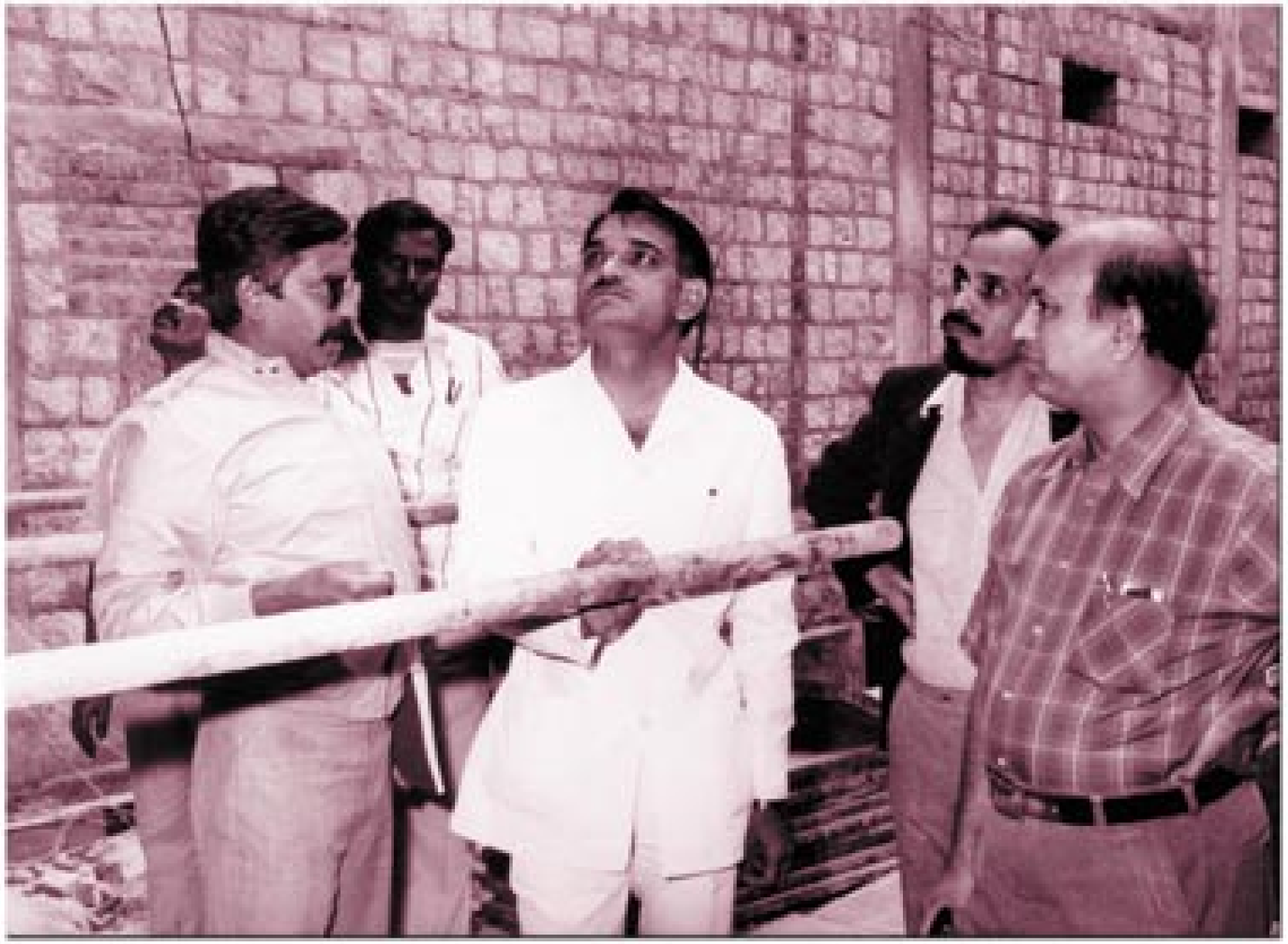


Typical results from CFD software at NAL. In the early 1980's, P Ramamoorthy worked with C L Narayana and others to create a CFD software library which was the precursor to SOFFTS.

Soon after taking over, Narasimha organised a series of scientific reviews involving his NAL colleagues and external experts. The first review, held in January 1985, on software in fluid and thermal sciences (SOFFTS), led to the decision to create the SOFFTS library.

Narasimha accessing the SOFFTS library.

Acoustic Test Facility

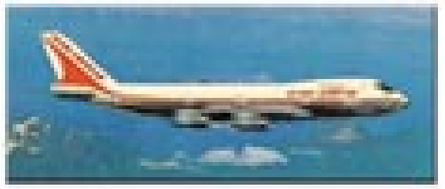


The ATF building.

Around 1983, NAL signed a memorandum, with Department of Space (DOS), agreeing to design and construct an acoustic test facility (ATF) for DOS on the Belur Campus. The facility, which constituted a formidable challenge for NAL scientists -- especially S Balakrishna and S Nagabhushana -- was ready in record time.

Shivraj Patil, who was also the Minister of Space, seen at the ATF site with S Nagabhushana, R Narasimha and U R Rao in 1985.

The Kanishka Tragedy



On 23 June 1985, Air India's Boeing 747 aircraft, Kanishka, which had taken off from Toronto, Canada, crashed off the coast of Ireland in mysterious circumstances. All the 300 + passengers on board died.

After the ghastly accident. Y Nayudamma, a former CSIR Director-General, was among those who died in the crash.

Y Nayudamma, second from right, on a visit to NAL's Instrumentation Division.

The Kanishka Investigation

V Ramachandran and his colleagues of the Materials Science Division were involved in the accident investigation. After carefully studying the wreckage recovered from the Atlantic Ocean, the NAL team confirmed that the aircraft crashed due to a chemical explosion in the front cargo hold.

V Ramachandran on the ship's deck off the coast of Cork in Ireland.

CAVITAS

NAL commissioned the computer assisted vibration test and analysis system (CAVITAS), developed jointly with HCL, on 18 July 1985.

Vivek Sinha, Chief Controller, R&D Ministry of Defence, inaugurated the system. R Balasubramaniam, who led the CAVITAS team from the Structures Division, is also seen.

CAVITAS enabled vibration tests to be conducted on a complete airframe with data reduction is real time: what tooks three months earlier could now be done in a few days.

Airframe of the Ajeet aircraft being tested using CAVITAS.

Visit of the Abid Hussain Committee

A top level CSIR Review Committee, under the chairmanship of Abid Hussain, visited NAL on 16 July 1986. The Committee made a series of important recommendations – including the recommendation that every CSIR establishment must earn at least a third of its revenue from external sources.

Abid Hussain (left) with R Narasimha, A P Mitra – who took over a CSIR's Director General in 1986 from S Varadarajan, and M Shivakumara Swamy at the NAL wind tunnel.

India's First Parallel Computer

Narasimha's interactions with his colleagues, especially those involved in computational fluid dynamics (CFD), convinced him that NAL's available mainframe computer was not sufficiently "powerful". It wasn't easy to buy a more powerful computer either because of cost and embargo constraints. Narasimha therefore constituted a group, in February 1986, led by U N Sinha, to build a more powerful computer for CFD applications at NAL itself. By the end of 1986, India's first parallel computer – called Flosolver – was operational!

Flosolver Mk1 architecture.

Think Composites

By the mid-1980's, it was clear that composite structures were the wave of the future in the aeronautical industry. The proposed LCA airframe too would involved composite parts. NAL therefore started a series of serious initiatives to gain experience and expertise in composite technologies.

A 2.4m x 6m autoclave built at NAL in 1986 to fabricate composite parts. The autoclave was commissioned in November 1986.

An Aircraft Out of Foam and Fibre

Early days in the LCRA fabrication. The pivotal role in the aircraft fabrication came from D V Bakshi and his team.

In 1983-84, NAL started the project to fabricate an all-composite aircraft using a kit bought from Rutan in USA. The project, led by R B Damania, gave NAL teams very valuable insights in building airworthy composite structures.

The aircraft, called the Light Canard Research Aircraft (LCRA), was ready by the end of 1986.

The Flight of the Light Canard

Damania exchanging notes with Wg Cdr P Ashoka before a LCRA flight.

The LCRA, with Wg Cdr P Ashoka, HAL's Chief Test Pilot, made its maiden flight on 26 February 1987. After the LCRA success, NAL seriously started the preparatory work to design and build a light aircraft (called NAL-LA).

The LCRA flying past the Bellandur Lake.

SAMIRA

NAL's wind energy programmes, first initiated in the 1960's, received a new impetus around 1980. The broad objective at that point was to design and develop innovative and cost-effective small windmills. By the end of the 1980's wind monitoring studies also gained prominence.

A prototype of the SAMIRA windmill designed and developed by NAL in 1986-87.

The Focus on Flight Mechanics and Control

The 1980's were exciting times in the Systems Engineering Division as S Balakrishna and his colleagues embarked on a series of new and challenging initiatives: in the mechanics of flight involving modelling, simulation, optimization and control and in novel dynamic wind tunnel simulation techniques.

S Balakrishna (right) and S Srinathkumar studying computer-generated results of control law analysis/design with F Henschel of DLR in November 1986.

Composite Rudders

Composite Do 228 rudder developed under the NAL-DLR Cooperation.

Composite MiG-21 rudder. This was the first indigenously built rudder.

Handing over of the MiG 21 composite rudder to HAL on 10 June 1988. B R Somashekar, M V V Murthy, A P Mitra, DG-CSIR, Wg Cdr I M Chopra, Chairman HAL, R Narasimha, M Subba Rao and K R Narayanan, Minister for Science and Technology and Vice President CSIR are seen in the photograph.

Two projects, undertaken during the mid-1980's, helped NAL establish capability in fabricating composite aircraft rudders.

1988 Foundation Day Function

a

Starting 1987, NAL established the practice of having an annual Foundation Day function featuring a Foundation Day Lecture and other events. C N R Rao delivered the first Foundation Day lecture. Raja Ramanna delivered the second lecture of the series on 11 June 1988. On the same day, K R Narayanan inaugurated the new aircraft hangar on the Belur Campus.

S R Valluri, Raja Ramanna, A P Mitra, R Narasimha, K R Narayanan and others at the aircraft hangar after the inauguration.

b

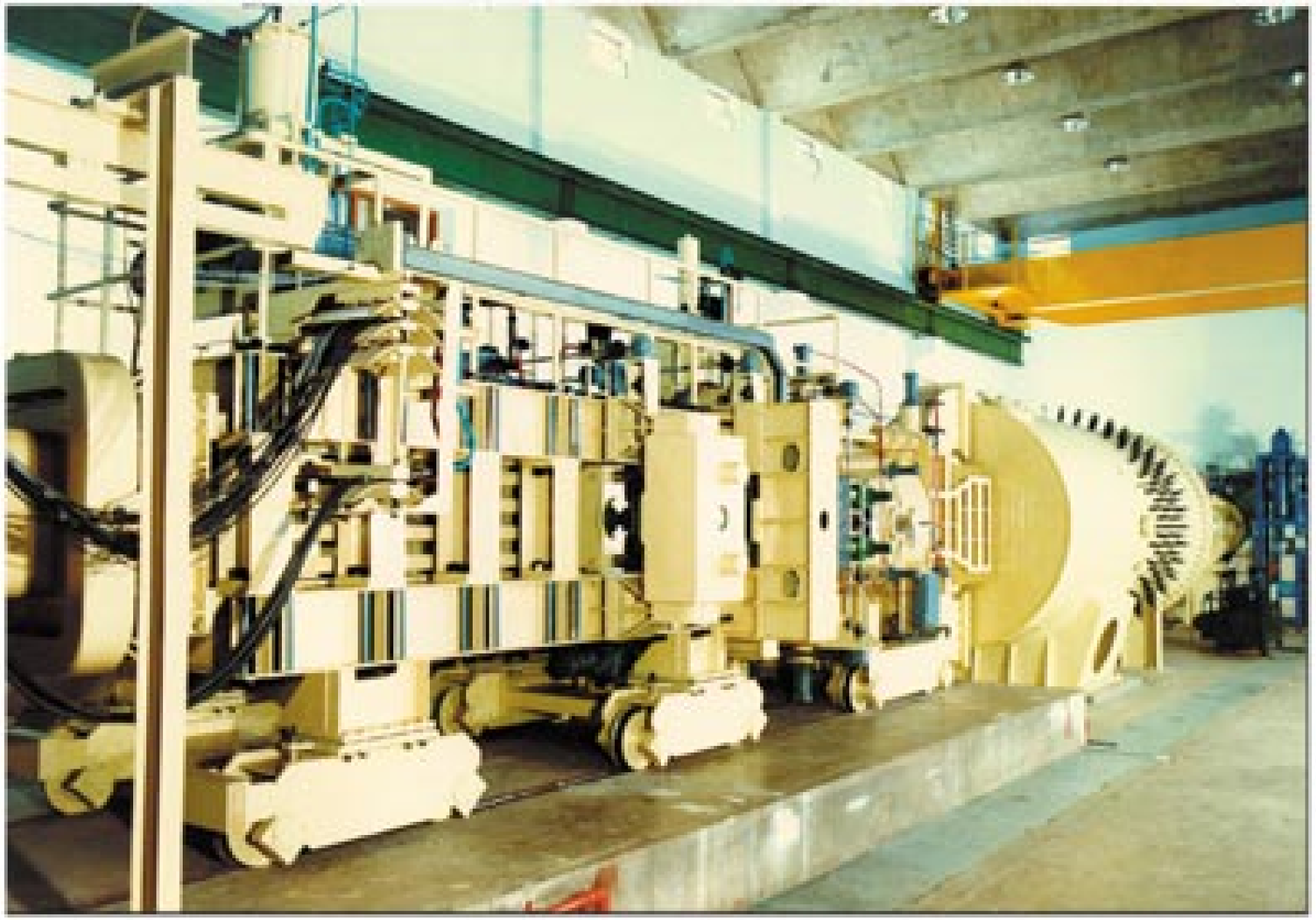
Lunch time at the NAL Guest House. A P Mitra, R Narasimha, Raja Ramanna, Satish Dhawan and K R Narayanan can all be seen together in this memorable photograph.

NALSUN

A solar-selective black chromium coating for water heating and other applications was successfully developed by S R Rajagopalan, Indira Rajagopal and their team at the Materials Science Division. By 1988-89, excellent reports about this coating's performance had already started coming in. NALSUN, which has international patents in different countries, still remains NAL's most commercially successful technology.

Solar collectors plated using NALSUN. Heating of up to 85°C can be consistently obtained using NALSUN.

Inauguration of 0.6 m x 0.6 m Transonic Wind Tunnel



The 0.6 m x 0.6 m transonic wind tunnel, the largest high speed facility designed and built entirely within the country, was inaugurated by S R Valluri on 15 May 1989.

A view of the new tunnel.

Valluri set to inaugurate the facility. Recovering from a serious illness, Valluri still appears a little frail.

The NAL Library

The NAL Library was – and continues to be – always a great joy to visit. Starting with six almirahs of books in the early 60's, the Library went on to become a formidable repository of books in science and engineering under the able and dynamic leadership of M N Seetharaman (who retired in 1987).

A view of the NAL Library in the 1980's. For almost a decade and a half, the Library kept acquiring an average of 100 books every month.

C-MMACS

By the late 1980's, as computing power started growing appreciably, and modelling or simulating large problems started becoming feasible, A P Mitra, DG-CSIR, and his advisers mooted the idea of a dedicated CSIR Centre for Mathematical Modelling and Computer Simulation (C-MMACS). The Centre was set up near NAL's Belur Campus in March 1988 and K S Yajnik was asked to lead and nurture the Centre.

R Narasimha speaking at the first intensive course organised by C-MMACS. K S Yajnik, V K Gaur and A P Mitra are seated on the dais.

1989 Symposia and Lectures

Sir James Lighthill returned to NAL after nearly two decades to deliver the CSIR Distinguished Lecture on "The Recently Recognized Failure of Predictability in Newtonian Mechanics" on 4 December 1989.

The Second Indo-USSR Symposium was held in February 1989. The end of the 1980's saw a sudden increase in scientific collaboration with the Soviets.

R Narasimha (speaking), C N R Rao, O M Belotserkovskii and G Prathap at the inauguration.

S Chandrashekar too delivered a CSIR Distinguished Lecture on "Newton's Principia" on 18 December 1989..

"Chandra" on a 1968 visit to NAL.

Joy and Sorrow in Manikaran

India's first geothermal pilot power plant, developed by NAL, DNES and other partners, was installed in August 1989 at Manikaran in Himachal Pradesh. The 5 kW power plant harnessed the energy contained in hot water springs. It was planned to use this power for street lighting in Manikaran. Unfortunately, shortly thereafter, a cruel landslide completely buried and destroyed the plant.

Trials on the geothermal power plant at the Propulsion Division.

80's Miscellany

a

A P J Abdul Kalam delivered the 1989 NAL Foundation Day Lecture on the "Agni Mission". Kalam received a thunderous applause as he entered the Systems Auditorium.

Sir John Eccles, the Nobel laureate, visited NAL on 6 October 1989.

b

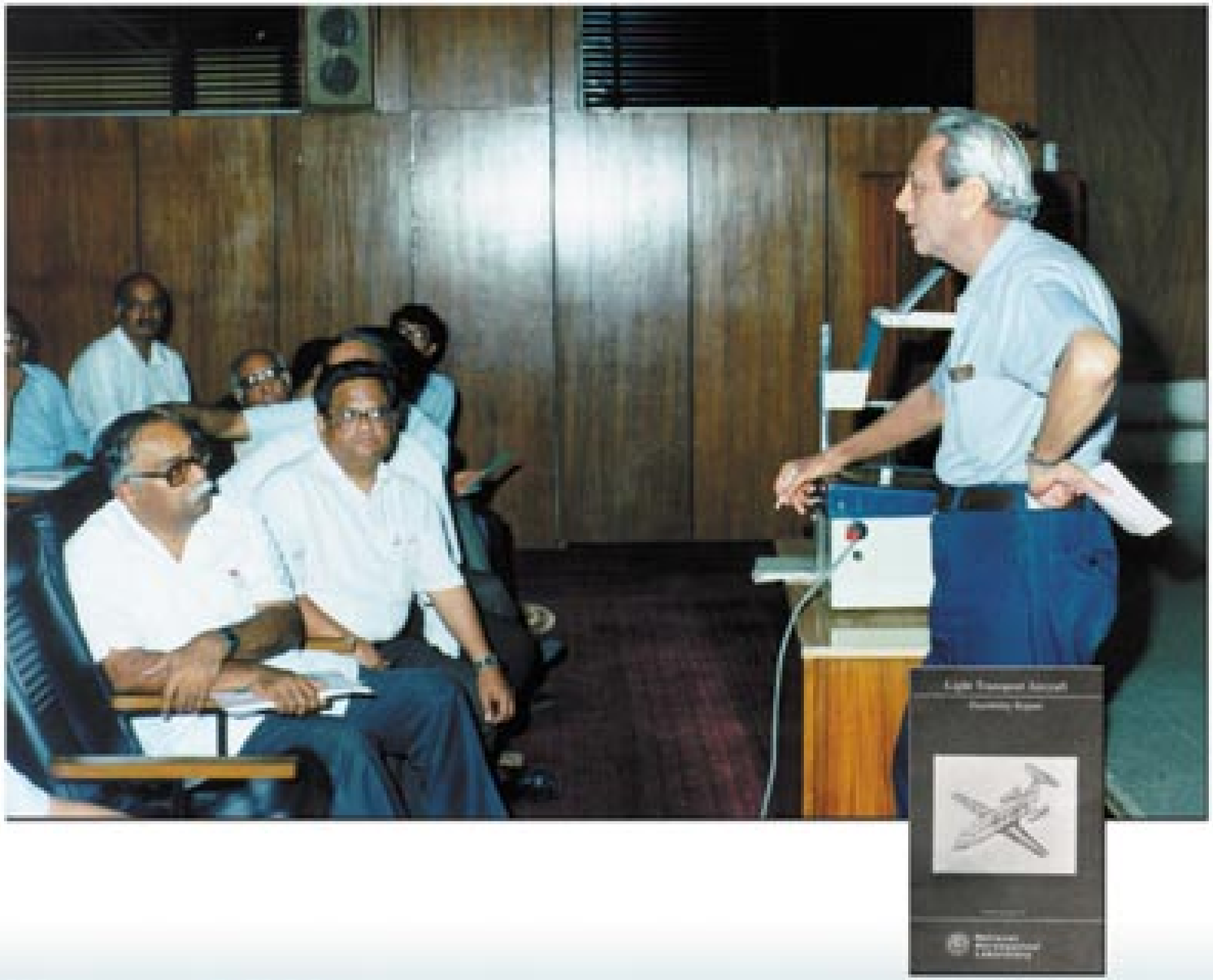
c

The NAL Employees' Cooperative Society celebrated its silver jubilee on 22 September 1989. Anant Nag was the chief guest.

d

NAL hosted the 21st Shanti Swarup Bhatnagar tournament on 24-30 December 1988. The chief guests were Brijesh Patel and A R Nizamuddin.

The Thrust on Civil Aviation



As NAL entered the decade of the 1990's, Satish Dhawan and his colleagues of the Research Council recommended that NAL should strongly shift its focus to civil aviation and small aircraft design and development projects. A series of strategy reports prepared by J P Singh and Raj Mahindra also highlighted the tremendous potential of civil aviation.

NAL arranged meetings with air taxi operators (4 June 1990) and industrialists (10 July 1990) to advocate the promise of civil aviation. Satish Dhawan is seen addressing a gathering of air taxi operators. A K Rao, A P Mitra can be seen. S S Desai and Raj Mahindra are partly seen.

Adventure

In 1989-90, ADA faced a very difficult situation. A ¼ scale high speed air intake model of the LCA had to be tested at the earliest in a French wind tunnel at ONERA. The model was exceedingly complex and foreign model makers were demanding an astronomical sum -- at a time when India's foreign exchange reserves were at their lowest. NAL accepted the challenge of developing this model. An inter-divisional team (perhaps for the first time) worked together and successfully completed the task. This achievement greatly strengthened the bond between NAL and ADA.

The ¼ scale LCA air intake model was handed over to ADA on 30 April 1990.

1000 Blowdowns

U R Rao, chairman ISRO, congratulates R Narasimha as S K Joshi, DG-CSIR applauds.

The Acoustic Test Facility (ATF) which began operations in 1986, continued its splendid run as it completed its 1000th blowdown on 4 March 1992.

A satellite placed in the 1100 cu.m reverberation chamber for acoustic testing.

Helping Nuclear Power Corporation

In response to an urgent request in 1989 from Nuclear Power Corporation (NPC), NAL successfully developed a process for nickel plating of stainless steel discs used as a seal against the leakage of heavy water in NPC nuclear reactors. Better still, NAL went on to design and commission a plant for the manufacture of these discs by 1991.

Production plant for the high speed nickel plating of seal discs.

CSIR Golden Jubilee Conference

a

The CSIR Golden Jubilee Conference on Technology and Industry was held at NAL on 12 November 1991. P Chidambaram, Union Minister of Commerce and Manorama Madhwaraj, Karnataka Minister for Heavy and Small Industries were among those present.

P Chidambaram delivering the inaugural address.

The Conference contained three sessions: on industrial development, technology development and financial implications. G Thyagarajan, S Varadarajan, S R Valluri, A V Rama Rao, Capt S Prabhala, A P J Abdul Kalam and Y S Rajan were also present.

Manorama Madhwaraj at NAL.

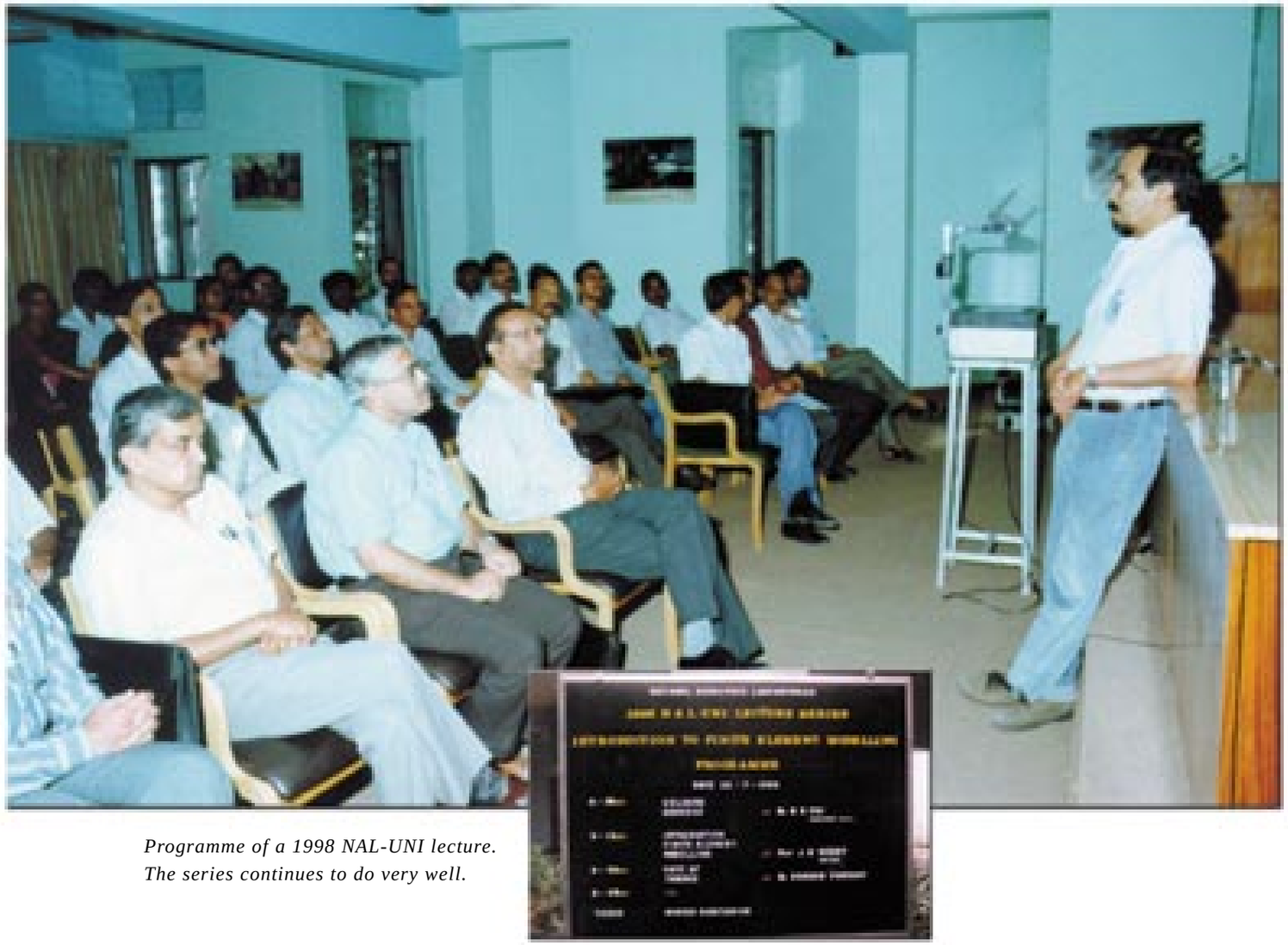
b

Academic Interactions

Realising that scientists and engineers possess a very special kind of domain experience -- not available in universities and text books -- Narasimha initiated, in 1992, the NAL-UNI Lecture Series in which R&D scientists and academics could interact profitably.

Narasimha also introduced the Graduate Trainee and Diploma Trainee programmes at NAL so that young graduates had an opportunity to work at NAL. This helped NAL too as these youngsters bolstered NAL's human resources and brought in fresh ideas.

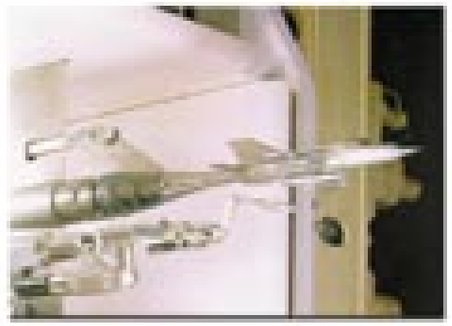
Participants at the first NAL-UNI course on "Theory and Practice of Parameter Estimation for Aerospace Dynamical Systems" held on 24-26 June 1992.



Programme of a 1998 NAL-UNI lecture. The series continues to do very well.

The Jewel in the Crown

The silver jubilee function of NTAF was held on 18 June 1983. G Rajendra, R Narasimha, S Dhawan and M Shivakumara Swamy are seated on the dias.



A fully captive trajectory system was installed in the 1.2 m tunnel in 1990.

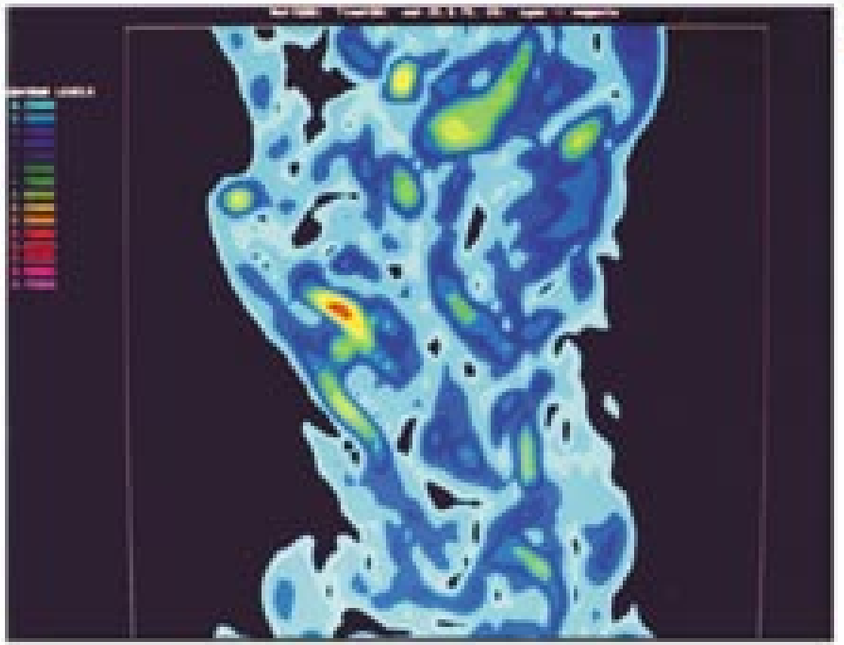
The National Trisonic Aerodynamic Facilities (NTAF) completed 25 years of operation in 1992; its 1.2 m trisonic tunnel is probably the best blowdown tunnel in the world. Every aerospace vehicle in the country has graduated out of this tunnel.

Dr B R Ambedkar Birthday Celebrations

In 1993, NAL started an annual event to celebrate B R Ambedkar's birth centenary. B Rachaiah, Governor of Kerala, was the chief guest at the first such function held on 29 March 1993.

M A Venkataswamy, Siddalingaiah, Professor of Kannada, Bangalore University, K N Raju, B Rachaiah and Nittoor Srinivasa Rao during the celebration function.

Breakthrough at Flosolver Lab



a

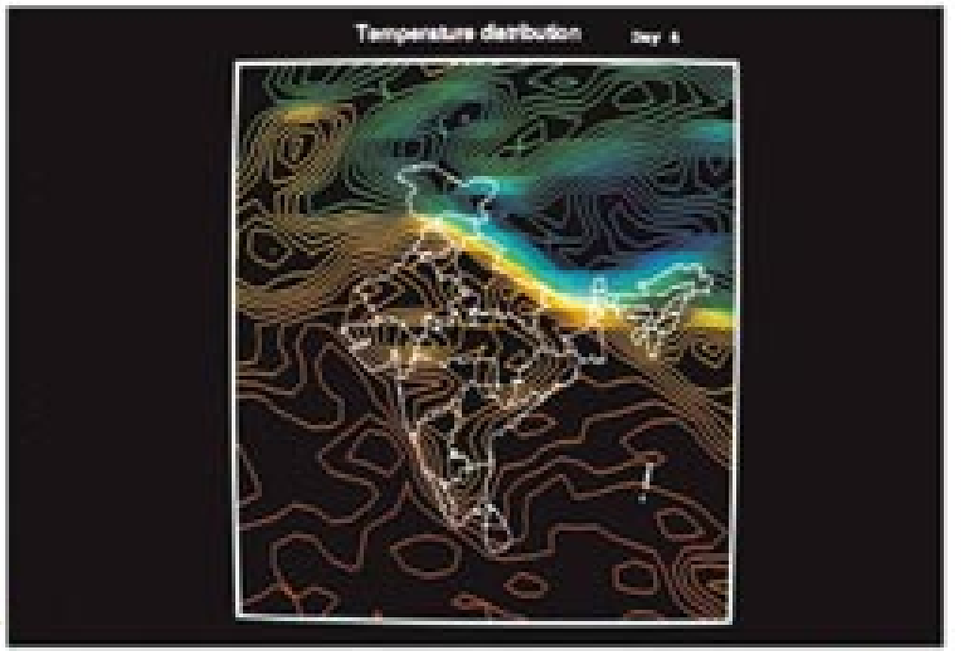
The Flosolver project, initiated in 1986, continued to blossom. In 1992, the Flosolver Mk 3 was used for direct numerical simulation (DNS) of turbulent flow for the first time in the country.

Simulation of turbulent flow on Flosolver Mk 3.

The Flosolver team also achieved a major breakthrough when the GCM T-80 weather prediction code was successfully ported and parallelised on Flosolver Mk 3 in 1993. A few years later, the GCM code was also completely re-engineered.

Wind velocity profiles computed on Flosolver.

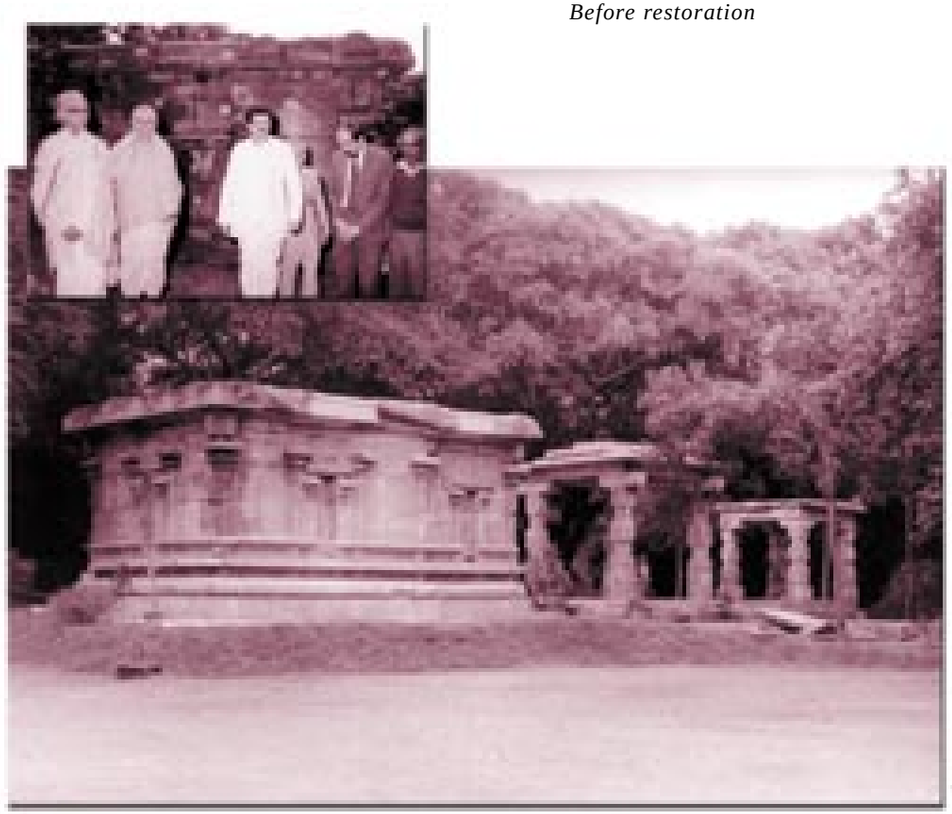
b



Belur Park

Deep inside NAL's Belur campus there was a temple, a few hundred years old, which was practically in ruins. Recognizing its historical value, the temple was restored in the early 1990's.

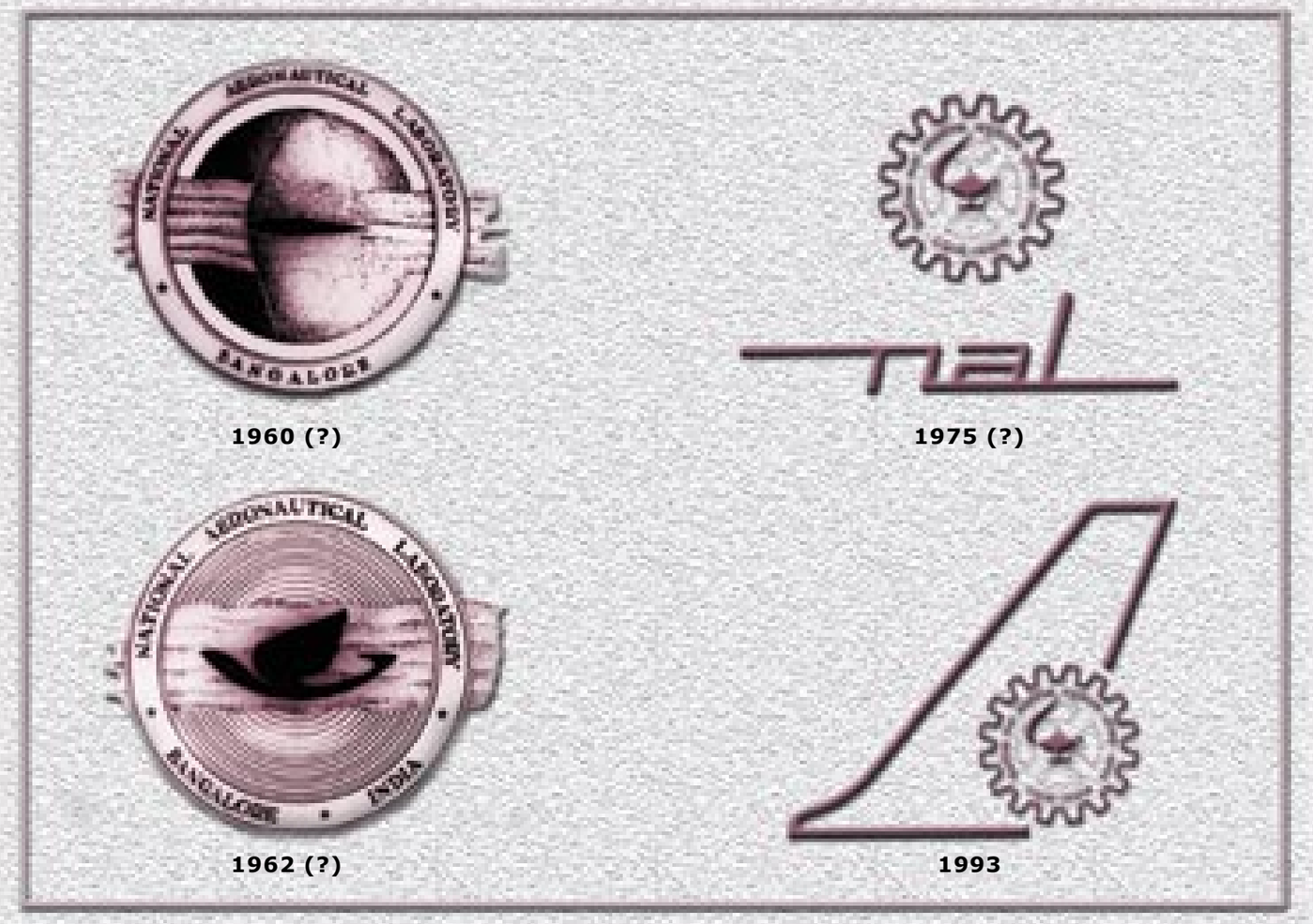
Before restoration



The area around the restored temple, full of big and shady trees, has now been converted into a park. It is now of the nicest places on the NAL campus.

The restored Someshwara temple. The inset shows Veerendra Heggade near the temple premises.

NAL is still NAL



On 1 April 1993, National Aeronautical Laboratory (NAL) became National Aerospace Laboratories (NAL). The new name recognised NAL's growing involvement in the national space programmes and the fact that the campus now really housed a conglomerate of individual laboratories.

NAL's logos over the years. The changing logos reflect NAL's evolving perception of its role as a CSIR and national entity.

Roddam Narasimha, FRS

H Narasimhaiah, former Vice Chancellor of Bangalore University, offers his good wishes to R Narasimha.

A P J Abdul Kalam releasing the proceedings of a Fluid Dynamics Symposium in honour of R Narasimha on his 60th birthday.

In March 1992, R Narasimha was elected a Fellow of the Royal Society of London.

17 years after initiating the 10,000th blowdown of the 1 ft (0.3 m) wind tunnel in 1976, Narasimha returned to initiate the 25,000th blowdown.

Narasimha Retires

The farewell function on the NAL Lawns.

R Narasimha retired as NAL Director on 31 July 1993. K N Raju took over as Acting Director.

After the farewell function, Narasimha posed for a photograph with NAL's Division heads and some others. Sitting (L to R): S N Seshadri, S S Desai, M Shivakumara Swamy, B R Somashekar, R Narasimha, K N Raju, P S Visvanathan, S Srinathkumar, R Srinivasan. Standing (L to R): B Kamalakar, Subbarayadu, S Krishnan, K Venkatachalam, G Rajendra, A C Raghuram, B R Pai, S K Tewari, S Nagabhushana, A K Singh, M R Narasimha Swamy and C G Shah.

HANSA Takes Off

The maiden flight of NAL's light trainer aircraft, now called HANSA, took place on 17 November 1993 with Wg Cdr P Ashoka in command. HANSA's success was a proud moment for NAL – and especially for R B Damania, who led the project. HANSA "officially" flew on 23 November 1993 and, immediately thereafter, at the Bangalore Air Show.

HANSA in flight.
Inset: R B Damania.

K N Raju Takes Over As Director

K N Raju was officially appointed as NAL's fourth Director on 30 March 1994. Raju was already the leader of the National Team of the LCA C-Wing project.

K N Raju showing an aeroelastic launch vehicle model to the Chief Minister of Pondicherry, V Vaitheeswaran.

SARAS Delays

In 1994-95, NAL's project to develop a 14-seater light transport aircraft – to be called SARAS – was still waiting for the Government's formal clearance although a great deal of preparatory work was already on. A new Centre for Civil Aircraft Design and Development (C-CADD) was created on 1 June 1995 to give a better focus to SARAS activity. The Russians had agreed to partner NAL in this project, coming in with their DUET aircraft proposal.

K N Raju showing the SARAS-DUET mock-up to G Y Krishnan, Minister for Civil Aviation. M Shivakumara Swamy, K Y Narayan and M A Venkataswamy are also seen.

Black Box Readout Systems

An integrated flight data processing (IFDP) system supplied by NAL to Air India on 4 May 1994.

Wreckage of the Airbus A320 aircraft which crashed near the Bangalore airport on 14 February 1990. NAL analysed the CVR of this ill-fated aircraft.

Around 1990, teams at NAL's Aerospace Electronics Division undertook a series of studies and projects involving the two aircraft "black boxes": cockpit voice recorder (CVR) and the digital flight data recorder (DFDR). Novel digital signal processing techniques were used to identify pilot voices and cockpit noises recorded on the CVR, and hardware-software interfaces were developed to read, analyse and plot aircraft performance parameters recorded on the DFDR.

LCA Models using Composites

Teams at the FRP Pilot Plant and the Central Design Section built a large number, and a large variety, of LCA scaled models for wind tunnel testing in the mid-1990's using composites. At a meeting in NAL to receive some of these models, Kota Harinarayana, LCA Programme Director, said that the NAL-built models were comparable to the best in the world.

LCA FRP scaled model handed over to ADA around 1994.

3m x 7m Autoclave Inaugurated

The Composite Structures Laboratory was inaugurated four years earlier on 16 June 1990, by V S Arunachalam, SA to RM.

Many of NAL's most important and memorable functions during the 1990's took place at the Composite Structures Laboratory. On 17 June 1994, R N Sharma, Chairman, HAL inaugurated the new computer-controlled 3m x 7m autoclave. A P J Abdul Kalam, SA to PM, was an unexpected visitor at this function. R Narasimha, C G Krishnadas Nair, Kota Harinarayana and T S Prahlad were also present.

The 3m x 7m autoclave which was inaugurated 17 June 1994.

14th ICNMFD

NAL played the leading role in organising the 14th International Conference on Numerical Methods in Fluid Dynamics (ICNMFD).

a

K N Raju, Director, NAL, inaugurated the Conference on 11 July 1994. Seated on the dais (L to R) are: R Narasimha, S M Deshpande, H S Mukunda, K N Raju, S Ranganathan and S S Desai.

b

The 14th ICNMFD, being held in India for the first time, had 220 delegates (90 foreign delegates) and 110 paper presentations.

A Jameson, Princeton University, USA delivering the valedictory address titled "Computational Methods for Aerodynamics Design" on 15 July 1994.

Other 1994 Headlines

21.7.94

Agreement to market NAL's finite element software FEPACS

5.8.94

Cooperation protocol between NAL and Chinese Aeronautical Establishment

25.8.94

U R Rao succeeds Satish Dhawan as Chairman of NAL's Research Council

1.10.94

Three NAL - TIFAC reports on civil aviation released in Delhi

10.10.94

First National Conference on High Pressure Science and Technology as a sequel to XIII AIRAPT

A K Singh decided that the profits from AIRAPT must fund an Indian Conference on the same subject

1.8.94

Second Training Programme on FRP moulding by NAL- SISI-CTD

Hands on training for future entrepreneurs

Dynamic Wind Tunnel

NAL's dynamic wind tunnel – pioneered by S Balakrishna in the early 1980's – offers testing options not possible in conventional wind tunnels, e.g. testing with up to three rotary degrees of freedom. In the mid-1990's, NAL used the tunnel for estimating damping derivatives using the novel concept of "dynamic wind tunnel simulation".

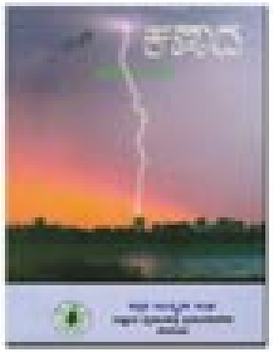
Testing of the rotodomed aircraft model in the dynamic wind tunnel in 1988.

The rotodomed aircraft flying at a Bangalore air show in 1998. Sadly, it crashed a few years later.

Karnataka Rajyothsava Functions

Karnataka Rajyothsava functions, normally held in the first fortnight of November every year, and other cultural events, are always eagerly awaited.

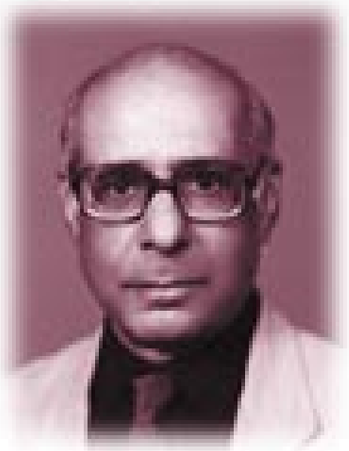
The thespian Rajkumar is greeted by K N Raju at a function in the mid-1990's. B R Somashekar, I R N Goudar, A C Raghuram and M R Suresh can also be spotted.



Kanaada, NAL's annual publication featuring articles on science and technology is released every year as a part of the Rajyothsava function.

The film artiste K S Aswath was one of the guests of honour at the 1995 function. He is seen with H Sundara Murthy at the NAL wind tunnel.

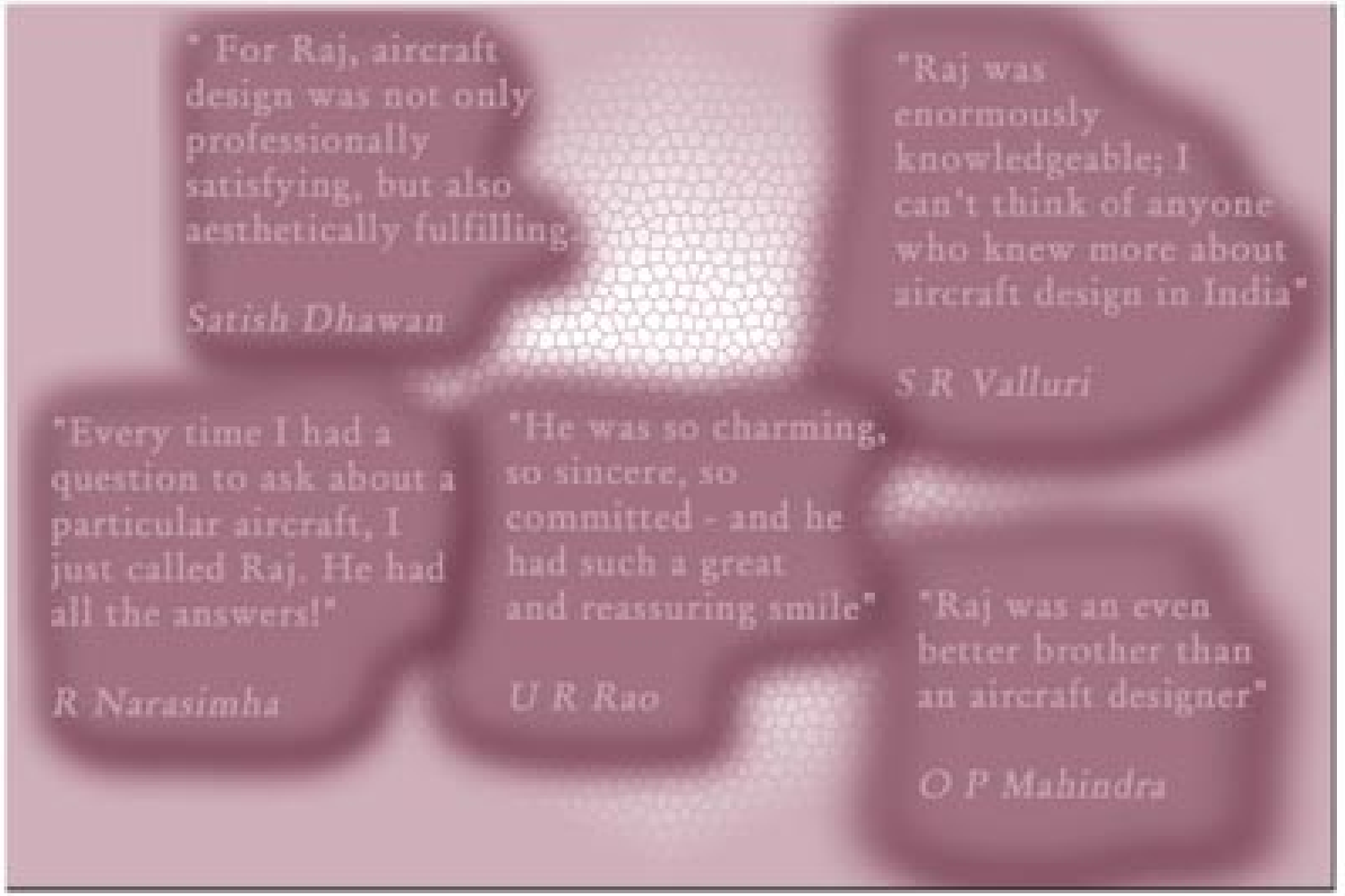
Raj Mahindra



1925-1995

Raj Mahindra, NAL's friend and well-wisher, and in many ways the guiding spirit behind the SARAS programme, passed away on 16 February 1995.

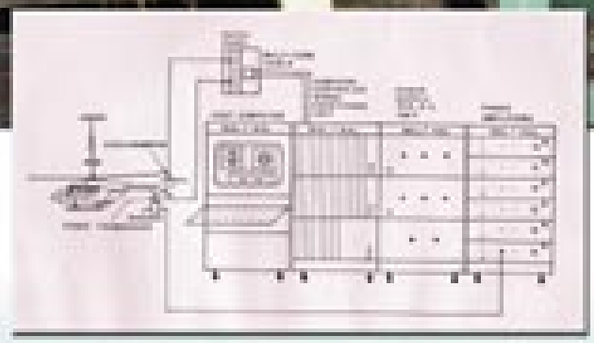
Tributes to Mahindra at the memorial service held at NAL on 20 February 1995.



Shake Test Facility

NAL's Director K N Raju handed over the shake test facility for HAL's Advanced Light Helicopter (ALH) to HAL Chairman, R N Sharma on 7 July 1995. The facility subjected the complete helicopter prototype to shake tests to assess the vibration levels and responses before flight tests.

The ALH completely wired up at the shake test facility.



Schematic of the facility.

LCA Control Laws

NAL continued to play a major supporting role in the light combat aircraft (LCA) design and development. A National Control Law (CLAW) team, led by S Srinathkumar, was set up in the mid-1990's.

NAL's Shyam Chetty (second from left), a member of the CLAW team, in front of the NT33-Inflight Simulator (IFS) at Calspan, USA, in June 1995. The LCA control laws were simulated on NT33-IFS and successfully validated through a series of flight tests.

"The LCA Now Has Its Wings!"

a

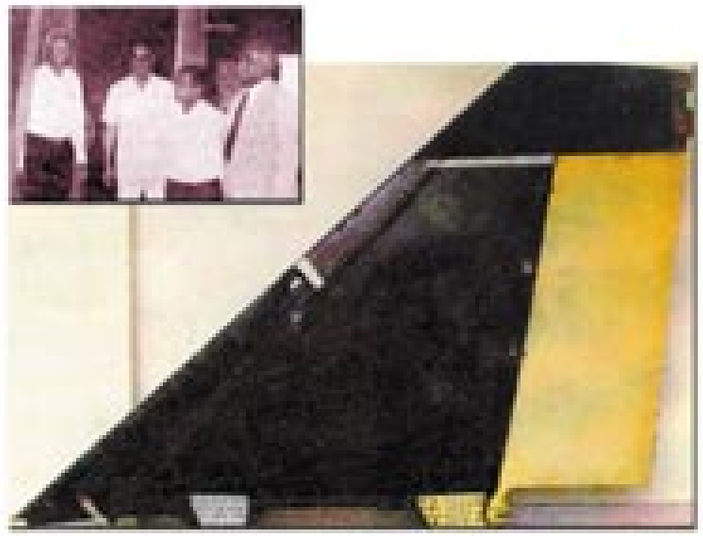
In what was an extremely satisfying moment for NAL – and for K N Raju and his colleagues of the C-Wing National Team – the first set of the fully-tested LCA wings were handed over by the C-Wing National Team (K N Raju) to ADA (A P J Abdul Kalam). Kalam lost no time in handing over the wings to HAL (C G Krishnadas Nair).

The LCA C-wing under production. The first set of wings was handed over on 21 October 1995.

Earlier, NAL (R A Mashelkar, DG-CSIR) handed over the co-cured composite fin and rudder of the LCA to ADA (Kota Harinarayana, PGD, LCA); who, in turn, handed the fin and rudder to HAL (R N Sharma, Chairman).

The LCA fin and rudder handed over by NAL in September 1995.

b



K N Raju Retires; T S Prahlad Becomes NAL's Fifth Director

K N Raju retired as NAL's fourth Director on 30 April 1996. T S Prahlad, Project Director (TD), ADA, immediately took over charge as NAL's fifth Director.

K N Raju greets his successor.

Warm greetings for K N Raju from CFTRI Director V Prakash.

HANSA Flies Again

One of T S Prahlad's first tasks was to get the HANSA project going at a quicker pace. Several issues, especially those related to certification, had to be urgent sorted out since the next HANSA had to be a production prototype.

HANSA-3 (VT-XAL) getting ready to take off. HANSA-3's maiden flight took place on 25 November 1996. The aircraft had its first "public" flight on 30 November 1996 and flew at the 1996 Bangalore air show. Gp Capt Ashok Bhagwat of TAAL flew the aircraft.

Flight Simulator

NAL's Flight Mechanics and Control Division built a flight simulation facility, chiefly to support LCA control law development.

The engineer-in-the-loop flight simulator.

R A Mashelkar, DG-CSIR, visited the facility on 15 July 1996. He is seen with S Nagabhushana, M S Rajamurthy, Padma Madhuranath and B R Somashekar.

The SARAS Synergy

By 1997, the troubled SARAS programme was beginning to find its feet. With the acquisition of the CATIA software, the detailed design activity progressed very well. NAL also made a conscious (and successful) effort to bring in more partners. The Technology Development Board (TDB) of the Government of India also promised to support the SARAS programme.

Working together for SARAS. Inset: CATIA plot.

Prepregs

Airframe manufacturers using advanced composites rely heavily on prepregs. It is therefore vitally important to indigenously develop technologies to produce aerospace-grade prepegs. In 1997-98, NAL successfully developed a process to produce such carbon fibre prepregs and transferred the knowhow to Indian Petrochemicals Corporation Limited.

Production of carbon fibre prepregs at NAL. A P J Abdul Kalam, Kota Harinarayana, A K Singh and T S Prahlad are seen in the photograph.

The equipment to manufacture prepregs.

"Nilakantan Wind Tunnel Centre"

a

The Wind Tunnel Centre on the Belur Campus was dedicated to the memory of P Nilakantan, NAL's first Director.

Y K Alagh, Minister of Science and Technology, unveils the commemorative plaque on 18 July 1997.

Cover page of the brochure.

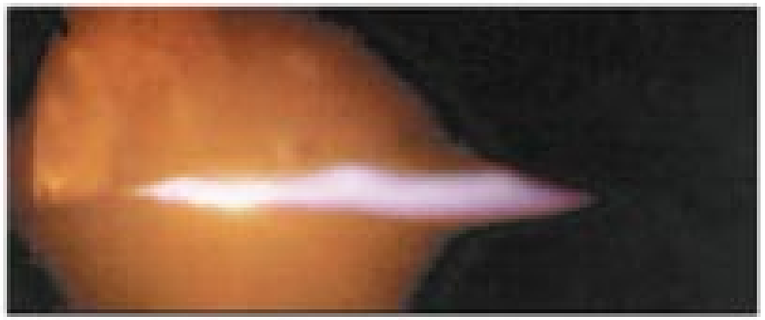
A special brochure recounting Nilakantan's effort to build the NAL wind tunnels was also released the same day.

b

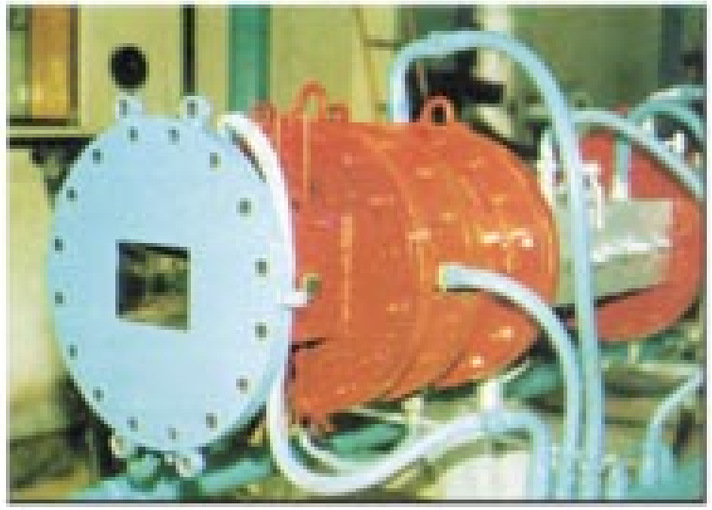
T S Prahlad, Y K Alagh and U R Rao on the Belur campus.

Supersonic Combustor

Low cost space operations can only be achieved by using *fully reusable* launch vehicles. This, in turn, would, among other things, require the technology for the design of supersonic combustors. In 1997-98, NAL's Propulsion Division successfully developed a supersonic combustor.



Hydrogen aided supersonic kerosene diffusion flame.



Two views of the supersonic combustor test facility at the Propulsion Division.

At Your Service

a

A large number of "employee-friendly" services are available on the NAL campus. There is a creche for infants (established in the 1990's), a nursery school (mid 1980's) and a Kendriya Vidyalaya (from the 1970's).

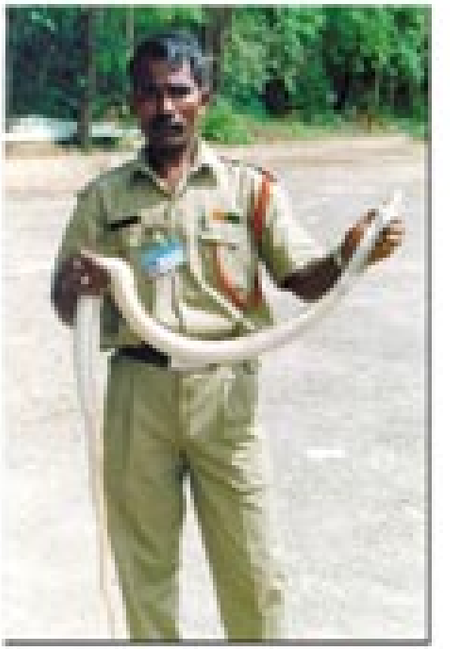
A function at the NAL Nursery School in the early 1990's. The school is a labour of love of Shyamala Valluri – the headmistress – and her colleagues.

NAL's Health Centre headed by Dr K S Nanjundaswamy has good facilites – and even better doctors.

The campus still has a fair sprinkling of snakes – although the population has dwindled since the 1960's and 1970's.

Sometimes there is a snake in the bedroom! Then K Viswanathan is called in. He catches the snake and then releases it far away – back to its natural habitat.

b



CSIR Directors' Conference Once Again

NAL once again hosted the CSIR Directors' Conference during 11-12 May 1998, at the Composite Structures Lab for security reasons. The Minister for Human Resources Development and S&T, Murli Manohar Joshi, was present right through the two-day deliberations.

T S Prahlad escorts Murli Manohar Joshi and R A Mashelkar, DG-CSIR, as the CSIR Directors assemble for the inaugural session.

Mid-way through the Conference, the news about the successful Pokhran nuclear tests came in.

Murli Manohar Joshi with R A Mashelkar at the NAL exhibition. The Minister later addressed a crowded press conference.

Santrupthi, CFTRI's Liaison Office. The foundation stone for this building was laid by Mashelkar on 10 May 1998.

HANSA VT-XBL Takes Off

The second production prototype of the HANSA (VT-XBL) had its first "official" test flight on 11 May 1998. HANSA VT-XBL, flown by Sqn Ldr Baldev Singh, was flagged off by Murli Manohar Joshi. The success of HANSA VT-XBL was the sweetest for NAL scientists because they had managed to trim down the aircraft's weight by over 100 kg – taking a big step forward towards the HANSA's ultimate type certification under the JAR-VLA category. With a lighter, and more powerful, Rotax engine, the HANSA "took off like a rocket".

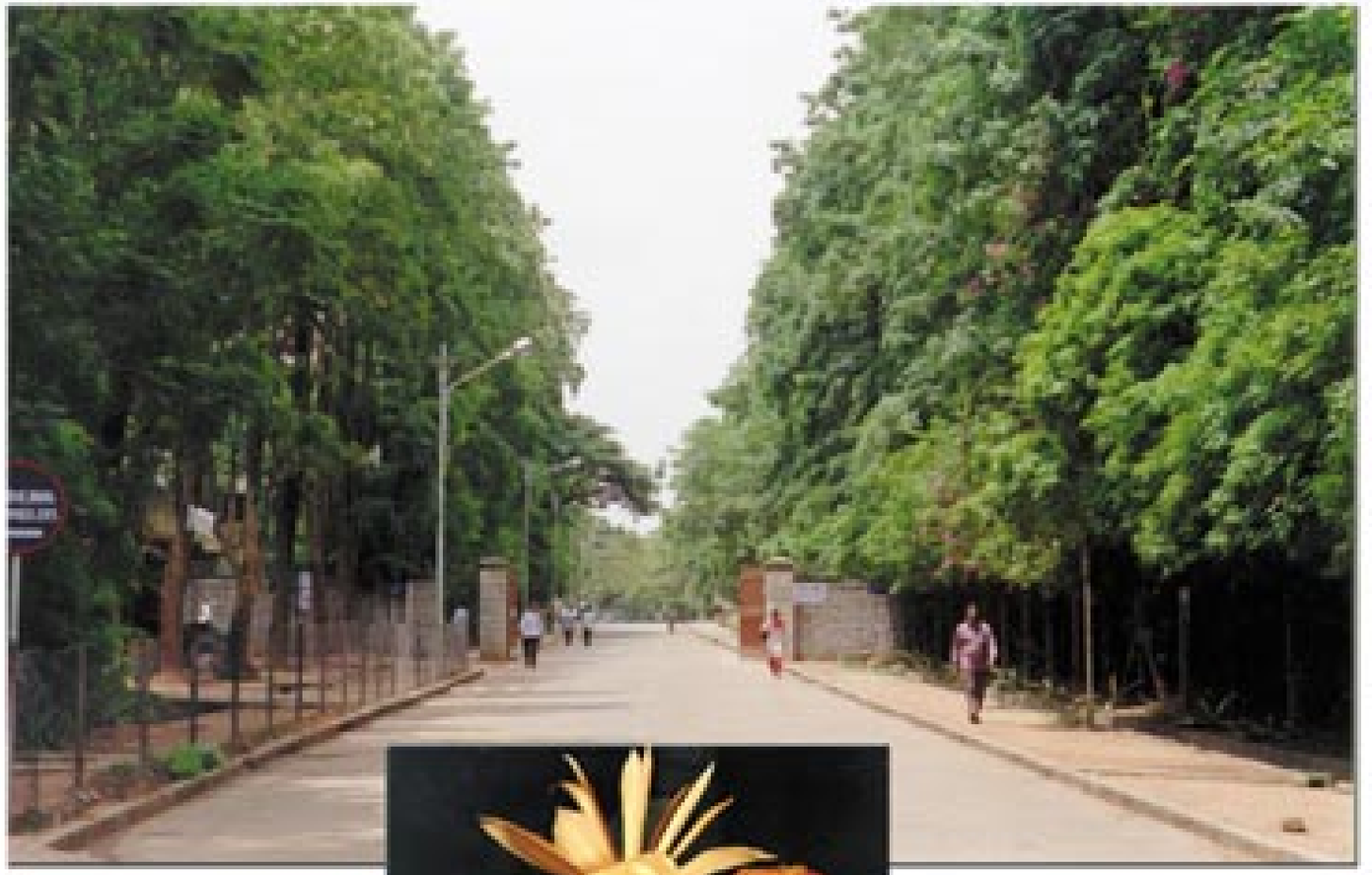
HANSA is airborne.

Murli Manohar Joshi, Minister for HRD and S&T (in the HANSA cockpit) and Ananth Kumar, Minister for Civil Aviation and Tourism, with Sqn Ldr Baldev Singh before the HANSA inaugural flight.

Green NAL

The NAL campus again received the award for the Best Maintained Campus from the Karnataka Governor in 1998-99.

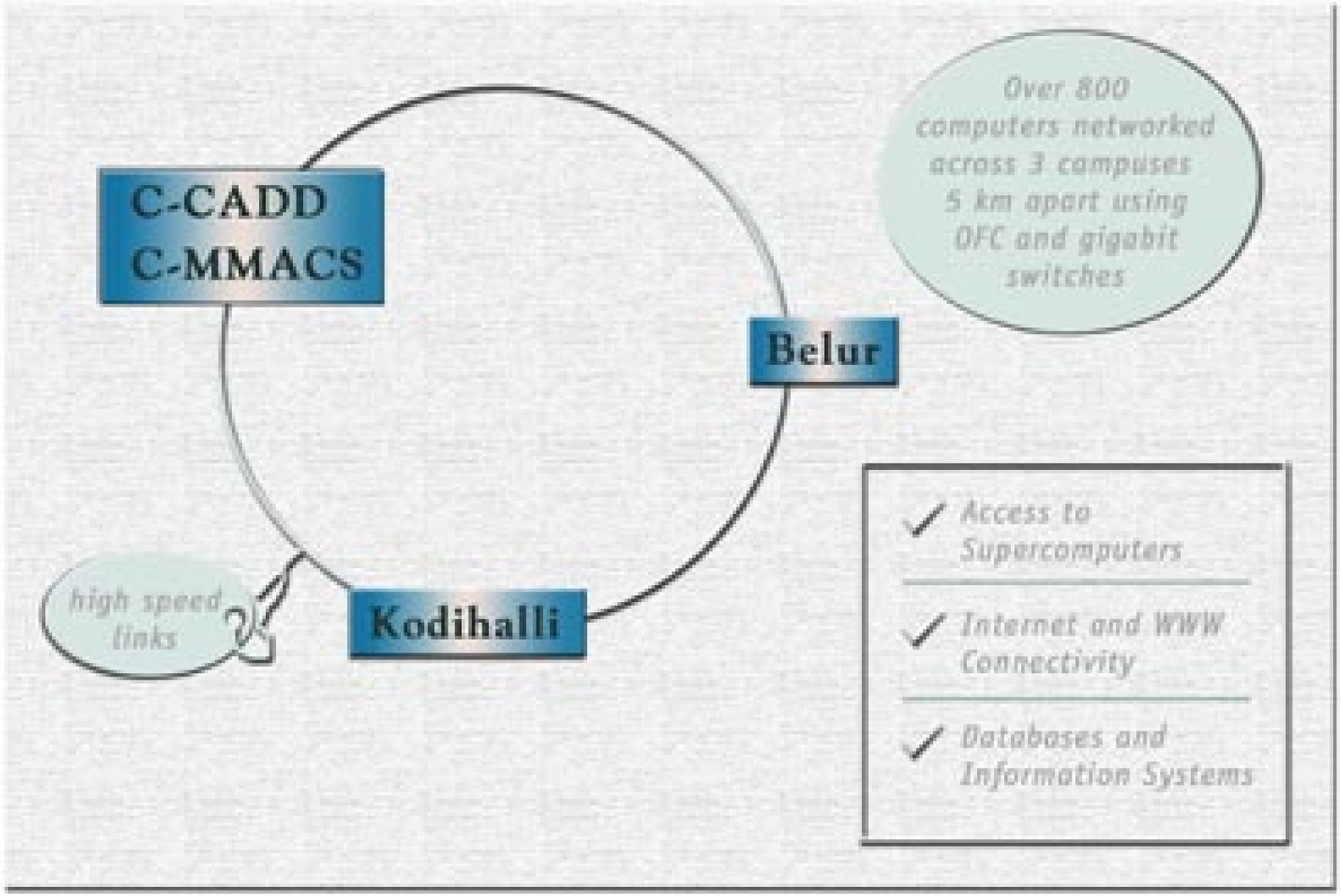
The NAL Campus received loving attention from T S Prahlad; starting 1997, both the NAL campuses are lovely, tidy and picturesque.



The pathway leading to NAL's Kodihalli campus.

A rare and beautiful flower blooms on the NAL campus.

Networked NAL



In 1996, NAL's network was slow and largely "disconnected" (the Kodihalli campus had no network at all!). Between 1998 and 2001, there was a sea change! NAL is now arguably CSIR's best networked establishment.

Salient features of the NAL computer network.

The Aviation Habit

To inculcate airmindedness among NAL staff members, two powered hang gliders (Altair and Clipper) were acquired by the Propulsion Division around 1997. By 1998 over 60 NAL members were given air experience on the 2-seat Clipper. In 1998 Altair was fitted with a suitably modified Wankel rotary engine.

NAL's powered hang glider.

SARAS Project Cleared

On 22 June 1999, The Cabinet Committee on Economic Affairs 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.

SARAS mock-up.

HANSA receives type certificate from DGCA

On 1 February 2000, the HANSA all-composite aircraft, with lightning protection and night flying capability, received its type certificate from the Director-General of Civil Aviation under the JAR-VLA category.

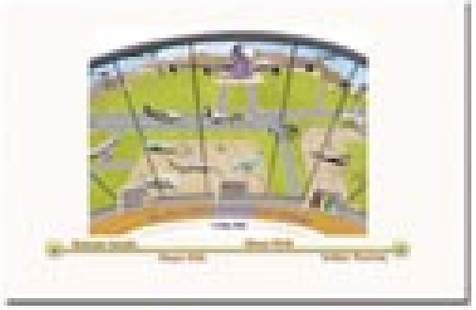
Air Marshal P Rajkumar, C G Krishnadas Nair, Chairman HAL, H S Khola, DGCA and T S Prahlad pose with the HANSA type certificate. Insets: Lightning test for HANSA and copy of type certificate.

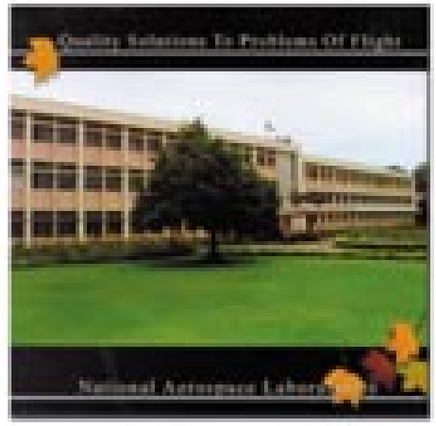
Databases and Information Systems

"Print"

"Web"

"Multimedia CD"





T S Prahlad actively encouraged the creation of databases and web-based information systems. At the Information Management Division (IMD), there were numerous projects undertaken involving the print, CD and web media. At the Information Centre for Aerospace Science and Technology (ICAST), there were successful initiatives in creating aerospace information portals (AeroInfo) and building inter-library networks. At the Structures Division, there were lankmark studies on civil aviation opportunities and markets.

A depiction of some of the activities at IMD involving the print, web and CD media.

Two Buses

NAL's Experimental Aerodynamics Division carried out wind tunnel studies on drag reduction of KSRTC bus configurations yielding very significant estimates of fuel savings.

KSRTC bus modified to minimize aerodynamic drag.

In an interesting spin-off application of composites, NAL's FRP Pilot Plant collaborated with the All India Institute of Speech and Hearing (AIISH) in 2000-2001 to develop a composite mobile bus for speech and hearing evaluation.

The low noise composite bus functions as a "travelling clinic".

Other Highlights in 2000 and 2001

22.9.00

NAL receives its ISO 9001 certification from Lloyds Register Quality Assurance

2001

K Kasturirangan Secretary, Department of Space and Chairman ISRO succeeds A P J Abdul Kalam as Chairman of NAL's Research Council

8.5.01

HANSA VT-HNT ferried to the Andhra Pradesh Aviation Academy (APAA)

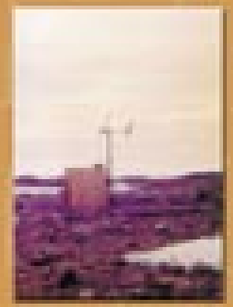
11.5.00

Flosolver MK 5 with a naval Flowitch is unveiled

The NAL-led group won the New Millennium Indian Technology Leadership Initiative (NMITLI) award for their proposal on mesoscale modelling of monsoon-related problems in February 2001.

2000

NAL installed a windmill at the Maitri Station in Antarctica for battery charging



LCA's First Flight

The successful test flight of the LCA TD-1 aircraft on 4 January 2001 set off a wave of celebration at NAL.

The LCA's first flight. NAL's support to the LCA programme was in the following areas: development of composite structures such as the fin, rudder, centre fuselage etc, support to, and the leadership of, the National C-Wing and Control Law teams, fabrication and testing of wind tunnel models, aeroelastic testing of LCA models and CFD studies on LCA configurations.

Handing Over of 4m x 8m Autoclave

The autoclave shell on its way from BHEL, Trichy to Bangalore in 1998.

NAL delivered the mammoth 4m x 8m autoclave to HAL on 12 April 2002. T S Prahlad, Director, NAL, delivered it to N R Mohanty, Chairman, HAL. Although the project in which BHEL, Trichy was the principal subcontractor, was considerably delayed, the autoclave is truly an engineering marvel.

The autoclave at the Composite Shop, ARDC, HAL.

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