

Roddam Narasimha Birthday Lectures



“ These eleven lectures offer far more than a glimpse of Professor Roddam Narasimha's remarkable intellect. They reveal a scholar of extraordinary range who moved effortlessly between fluid dynamics, meteorology, aeronautics, Indian scientific traditions, philosophy, history and public policy, always uncovering unexpected connections and fresh ways of looking at familiar problems.

His lectures combined profound scholarship with elegance, wit and quiet personal charm. Read together, these lectures offer an intimate portrait of one of India's finest scientific minds in full flight—and remind us that true scholarship is measured not only by the discovery of new knowledge, but by the ability to connect ideas, inspire curiosity, and enlarge our understanding of the world. ”



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Prof R Narasimha Memorial Lectures

2022

Challenges and Capability in Experimental and Computational Aerodynamics in the Indian Space Programme

Shri S Somanath, Chairman, ISRO

2023

Swing, Reverse-Swing and Knuckle ball: Transition of Boundary Layer

Prof Sanjay Mittal, IIT Kanpur

2024

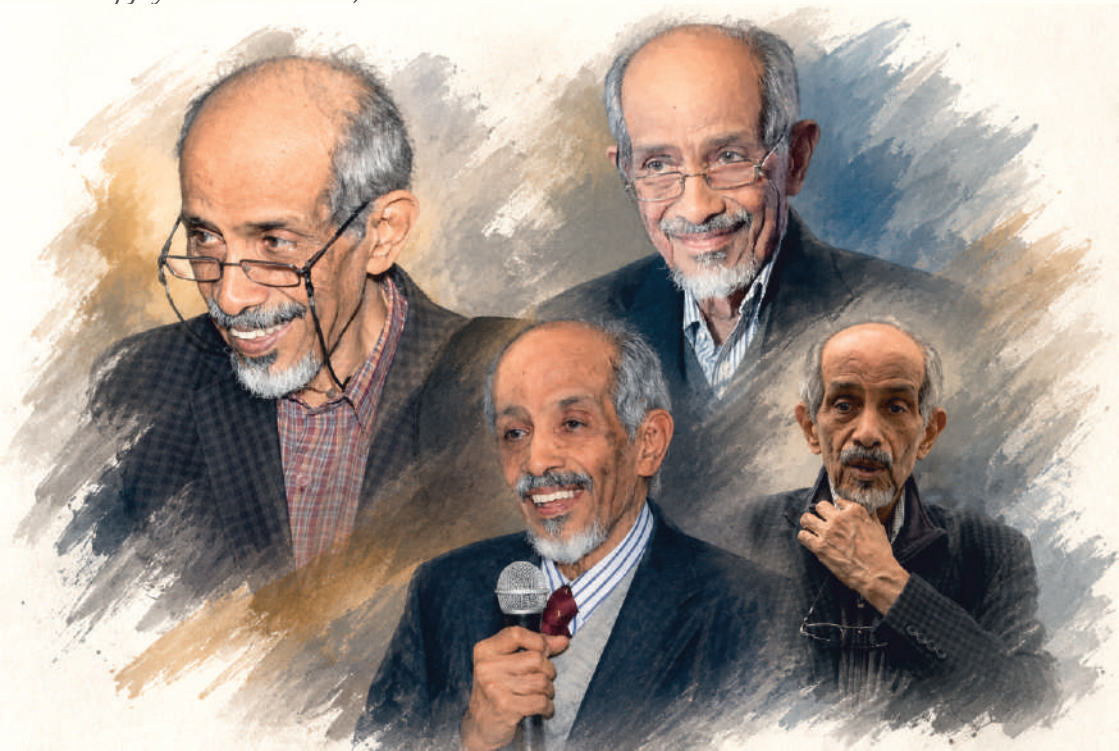
Complex System Approach to Investigate and Mitigate Combustion Instability in Turbulent Combustors

Prof R I Sujith, IIT Madras

2025

Fishy Tales and Wagging Tails: Underwater Locomotion

Prof Jaywant H Arakeri, IISc



Foreword



I remember attending many of Professor Narasimha's "birthday lectures", and I'm happy that we are now compiling these reports in a formal NAL publication.

Besides being illuminating and enjoyable, the lectures also allowed us to get to know Prof RN better, appreciate his thought processes and experience his immense personal charm.

Prof RN was an eternal optimist, and this positivity radiated through each of his lectures. He believed that big things can happen if we have the vision, courage, and confidence in our capability.

I experienced this first hand as a member of the LCA (now Tejas) flight control law team. He was confident – even more than us! – that the team would succeed. Prof RN challenged his teams, suggested sound and simple R&D strategies, and navigated us past the goal post. He was truly the quintessential guru.

Dr. Abhay A Pashilkar
Director, CSIR-NAL

Between 1999 and 2012 Professor Roddam Narasimha (RN) delivered over a dozen “birthday lectures” at NAL, most often at NAL’s Flosolver Lab.

These lectures, the brainchild of Dr U N Sinha and delivered around RN’s birthday on 20 July, became phenomenally popular at NAL, and an occasion to honour and celebrate the eclectic brilliance of a towering Indian scientist and researcher.

RN confessed that delivering “your own birthday lecture” was a trifle embarrassing, but admitted that he enjoyed the experience and the stimulating intellectual interactions.

This booklet compiles reports of eleven RN’s birthday lectures. Written by Srinivas Bhogle, Gopal M Kamath and Vidyadhar Y Mudkavi, they first appeared in the NAL Information Pasteboard.

“I would just sit in awe and listen to the great man talk. He had so much to say about many topics; his knowledge and insight on aerospace was awesome.”

- Ramesh Sundaram

“While at NAL, an event I eagerly looked forward to was the annual “birthday lecture” of Prof. Narasimha. To guess and anticipate the topic of his lecture each year would be as exciting and challenging, if not impossible. The range and breadth of what he spoke about (and what he could speak about) was vast and remarkable. He was a true polymath.”

- Gopal M Kamath

“His birthday lectures at NAL once a year encompassed a breath-taking range - to paraphrase Shakespeare: Age did not wither, nor custom stale his infinite variety.”

- L Venkatakrishnan

“His birthday lectures were very special. In one of his lectures, he referred to the Wright Brothers as a combination of a thinker and a tinker. He began his eloquent lecture on weather prediction with an evocative picture of a stone hung from a tripod of wooden logs.”

- M S Rajamurthy

1999

Fluid Dynamics: Ten years from now



NAL's Flosolver Unit appears to be caught in a web of perennial change. Every month Dr U N Sinha is turning the place inside out, shifting tables, chairs, books, tea mugs, logic analysers and computers. Such frenetic activity is usually a sign that Dr Sinha is in the midst of another tryst with technology. It will be this *Pasteboard's* privilege to report on Dr Sinha's latest rendezvous with success ... at some later date and time.

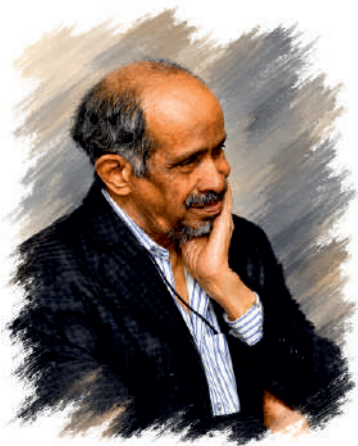
The present note is, however, to report on something that, to everyone's great delight, never changes at Flosolver Unit: the annual meeting to greet Prof Roddam Narasimha on his birthday on 20 July (for the record, he's now 66 – a fact which must be stated because, looking at Prof RN, you'd never guess). The lecture was at the unusual time of 12.45 in the afternoon, because the 66-year-old gentleman was in the middle of another extraordinarily busy day. But the odd time was no barrier; RN's legion of admirers (and that number is growing all the time) turned up in large numbers to greet the master, and were rewarded with another splendid and insightful lecture. "Every lecture by Prof Narasimha is such a sublime and elevating experience. I would never miss one", Dr S K Saxena later said, echoing the predominant sentiment of the audience.

Prof Narasimha spoke on *Fluid dynamics research: 10 years from now*. Warning the audience that everything he was saying might turn out wrong ("our track record in such predictions is extremely poor: in 1990 we talked of cold fusion and warm superconductors, but not of the Internet!") the good professor said that we must still "try to predict". After an illuminating, but

rather brief, narrative full of homilies ("it seems that with the passing of a decade or century many things in history are naturally 'expected' to end -- even physics was thought to have 'ended' by 1900"), observations ("just one paragraph in a 1904 Prandtl paper, where he wrote about the boundary layer idea, summarized the entire foundations of fluid mechanics!") and introspection ("the problem in the next millennium will not be how to generate data; it will be how to make sense out of an endless deluge of data"), Prof Narasimha summarized his predictions on fluid dynamics as follows:

- Fluid dynamics research won't end!
- High Reynolds numbers (Re) will still bring surprises
- A lot of modest Re might die; but it will continue to offer promising technological opportunities
- Computational fluid dynamics (CFD) will get increasingly industrialized
- Flow control will remain a central technical concern
- New 'convergences' (e.g., geophysical-technological) will emerge; they must be exploited.

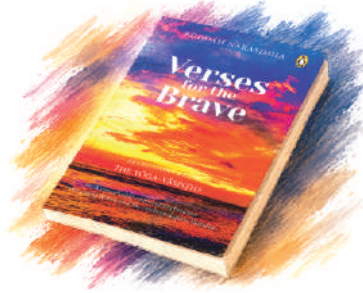
It is not for lesser mortals to make similar predictions; but we can hope and wish -- and ardently. So, we wish Prof Narasimha many, many more years of fluid dynamics and happiness, of contributions to science and polity, and of simply being with us. He probably doesn't realise that his mere presence is like a shining beacon to so many of us. We all need inspiring idols to make our lives more productive and meaningful. So, thank you, Prof Narasimha -- and happy birthday! /SB.



"The problem in the next millennium will not be how to generate data; it will be how to make sense out of an endless deluge of data"

2000

Verses for the Brave



The title was intriguing. "I don't even want to guess what Prof Narasimha is going to talk about. But I am sure that it will be something illuminating and imaginative", Dr T S Prahlad, Director, said as he welcomed his illustrious predecessor for his "Birthday Lecture" at NAL on 24.7.00. The "Birthday Lecture" is delivered every year by Prof Roddam Narasimha just after he turns a year older (he's now 67), usually at the Flosolver Lab. Last year he spoke on Fluid dynamics research: 10 years from now; two years ago, he spoke on *Cloud-like flows*. This year's title suggested a significant change of course; "could Prof RN be finally getting a little old?" we wondered.

Well, maybe. Actually, it would be more correct to say that the good professor is getting "older and wiser". What prompted Prof Narasimha to talk about his reading of the Sanskrit manuscript of *Yoga Vasistha*, believed to span an 18-day dialogue between Rama and the sage Vasistha, was the fact that it "strongly rejected fate". "I was struck by the articulation of such a different philosophy. It was also so forcefully expressed ... there was such verve, force, humour, lyricism and logic in the verses that reading them actually became a minor obsession with me."

When a great scholar gets obsessed with a manuscript the outcome is usually a magnificent exposition. I have heard lectures by Prof Narasimha for over 15 years now but seldom seen him in better form. He began with samplers from the manuscript to introduce his viewpoint: *fate has been invented by fools ... the wise (prefer) manly effort; or absorbed in every little greed and dependent solely on fate ... they are meek, they are natural fools*, and then formally introduced the *Yoga Vasistha* ("a long philosophic poem which uses nested dialogues to narrate nearly 50 scattered stories -- about

dreams, superhumans or reincarnations -- always with the objective of conveying a definite, forceful message"). This was followed by an account of one of the most popular stories from the collection: about how Queen Cudala first finds liberation and then helps her King also find it (I liked the stylish underplaying of what appears to be an outrageously amorous tale; the moral is "don't renounce the world, only renounce excessive attachment").

Finally came the piece de resistance as Prof Narasimha actually discussed dozens of ("my biased selection of") verses from the *Yoga Vasistha*. The verses eulogize reason (*only by analysis: he has no other way; or sin – so called – is ignorance ... that analysis can slay*) and commend effort (*a bold man crushes fate ... with faith in his own effort*). Elsewhere the verses compare the past and the present (*the past can be swiftly overcome ... by manly effort in the present*) and marvel eloquently at the physical world (*like the blueness of the sky ... a mere lovely sensation*). There are also delightful instances of playful, but balanced, repartee between Rama and Vasistha which prompt the sage to exclaim *we shall between us ... make a fine pair indeed*. For Prof Narasimha the *Yoga Vasistha* is notable for its unequivocal rejection of fate, emphasis on the value of analysis and effort, enthusiastic endorsement of participation in worldly affairs (nothing could be more reprehensible than retiring to the forest), rational world view, liberal view of gender, caste or nation and its invitation to healthy *joie de vivre*.

There were many reactions as the packed audience poured out into the lobby after the lecture. For some (including this writer) the highlight was the brilliant (sometimes even mesmerising) prose in Prof Narasimha's English translations. I haven't heard him talk too often about "purple clouds decorated with little frills", about "splendour of perception in the belly of an atom" or, best of all, about a "cool gladness in the heart". A second reaction was to express admiration at how a hardcore scientist had embraced philosophy. But the most unusual view was that Prof Narasimha is now ready to become a human resource management expert ("see how forcefully he advocated the virtues of effort and reason!"). Most individuals are at the end of their tether when they are 67. How wonderful and reassuring that new doors keep opening for this remarkable gentleman. But as the *Yoga Vasistha* says somewhere: *human energy is what matters!* We wish Prof Narasimha many more years of energy, passion and accomplishment. /SB.

2001

The Convective Lure of the Tropics

$$L \equiv \frac{C_p \rho_0 U_*^3}{k \beta Q_*} = \frac{U_*^3}{k g \alpha w' T'_v};$$

Shouldn't we really be talking of "the (addictive) allure of Roddam Narasimha (RN)"? He's now 68, but the glow and charisma refuses to fade. A year ago, when he spoke at NAL on Verses for the Brave, some of us thought that he's finally beginning to speak like a 67-year-old. Certainly, it was my private impression that RN is finally moving towards "softer" themes; rather like a Kapil Dev cutting down on his bowling speed, or a Lata Mangeshkar eschewing the high notes. His 2001 "20 July lecture" dispelled this impression. The original fire still burns within. RN might be heard talking more often these days about "digitizing India's cultural heritage", but "turbulent convection in the atmosphere" is still his first love.

But I do see one significant change. His prose is getting more lyrical. I have often thought that RN sacrifices flair for rigour in his writing and utterances. Thankfully, that appears to be changing; the romantic bottled up within is finally coming out. It was a pleasure to attend a technical exposition by RN which contained references "to the drama that is being played out in the sky - a drama featuring rains, squalls, storms and gales", and joyfully agreed that "the cumulus cloud is the queen of beauty in the atmosphere".

The lecture itself had two distinct parts. It began with a tribute to the tropics and made the important point that 300 years ago the tropical region was largely the land of prosperity, with plenty of sun, water and fertile soil ("today we perceive the region to be poverty-ridden and intolerably hot, but this wasn't always the case"). It then went on to argue why the tropics must be the subject of intensive study ("45% of the world's population stays here, and 45% of the land area is here") and finally talked of two very promising new research initiatives: the Indo-French *Megha-Tropiques* proposal to position a satellite exclusively to "watch" the tropics - to study water cycles and energy exchanges in the region - and the NAL- led New Millennium

Indian Technology Leadership Initiative (NMITLI) for mesoscale modelling of the tropics and the monsoon.

In the second part, RN talked of some of his recent research work on the fluid dynamics of tropical meteorology. The tropics, he explained, are characterised by very small temperature gradients ("there isn't really a great difference between the temperature of Trivandrum and Delhi") and very low mean wind velocities ("we have occasional cyclones, but this is a region of very low winds"). We would therefore require new mathematical models for the tropics consistent with these meteorological observations. RN and his colleagues are very excited because they believe that they have found a new formulation! "A great deal of what happens in the tropics in terms of the boundary layer and heat fluxes is best modelled by our weakly forced convection theory", he says. While most of us lack the ability to join RN in his latest research excursion, we can certainly share his joy and applaud his achievement. Dr U N Sinha tells me that the new theory is uncanny and beautiful. "What we believed to be a strongly uncorrelated maze of atmospheric data suddenly gets neatly lined up!", he says.

This is also great news for the NMILTLI and could be an important first step in the dream to build a supercomputer which will make the best weather predictions for India and the tropics. As always, Prof Narasimha was warmly received at NAL by Dr Prahlad and his other "dear friends on the campus" when he arrived to deliver the lecture. "It's always a privilege to receive RN and marvel at his new interests and penetrating insights. This lecture is in fact his birthday gift to us", Dr Prahlad said. We wish Prof Narasimha many more years of scholarship and happiness. Perhaps his next July lecture should be titled *How to keep the fire always burning*. It is my impression that many of us would benefit from such advice. /SB.



"300 years ago, the tropical region was largely the land of prosperity, with plenty of sun, water and fertile soil."

2004

An Affectionate Tribute to Ludwig Prandtl



For his birthday lecture this year at NAL - on 20 July 2004 - Prof R Narasimha chose to pay a glowing tribute to Ludwig Prandtl. Talking of the famous boundary layer paper that Prandtl wrote a hundred years ago in August 1904, Prof Narasimha said that the history of modern fluid dynamics can be traced to just one page of that paper.

I have heard Prof Narasimha speak for 20 years now, but seldom heard him pay such a warm and affectionate tribute. Prandtl is clearly one of his great heroes. In fact, Prof Narasimha was so captivated by Prandtl's portrait, drawn by V M Ghatage for IISc's Aerospace Engineering Department, that he got it photographed so that he could keep it. "Now I see that the painting's lost or disappeared. We've lost a piece of history. I'm sorry I didn't steal that painting myself!"

Prof Narasimha called Prandtl an engineering scientist -- and with good reason. "I have no doubt that Göttingen - which was like a 'German Cambridge' those days - had better mathematicians, physicists and engineers than Prandtl; but Prandtl alone possessed that divine mix".

Prandtl was an avid observer. He spent a lot of time observing fluid flows. The endeavour was to understand ("in today's jargon, you could say that the approach was 'holistic'"). Prandtl was also a 'minimalist'; he was always looking to see what would happen if he dropped a certain factor or effect from an experiment or equation. The quest was always to understand and explain the 'big picture'.

The lecture also contained some delightful insights of Prandtl as a human being. There was no fuss about him, there was no fanfare; he always came through as someone very thoughtful and modest. Even his papers made no tall claims; the writing was supremely confident, but one never detects even a hint of arrogance.

Prandtl was a proud German. He never thought of leaving Germany even at the height of the Second World War. There was much speculation if he was a Nazi sympathizer, but it's more probable that he was merely naïve and innocent. Prandtl was also a devoted husband. He often asked his wife to read out a book to him before bedtime; and, after his wife died, he continued to play her favourite tunes on the piano for her.

I've looked up the NAL archives and find that this is probably Prof Narasimha's seventh birthday lecture: he spoke in 1995 on the future of aeronautical fluid dynamics, in 1996 on cloud-like flows, in 1999 on the likely directions in fluid dynamics research a decade later, in 2000 on *Yoga Vasishtha's* verses for the brave, in 2001 on tropical weather prediction and in 2003 on Indian sines.

Each lecture has been remarkable, and full of insights and scholarship. It is one of the joys of being in NAL that we can share the company of an engineering scientist who's so much in the Prandtl mould himself. We wish Prof Narasimha a very happy 71st birthday, and we thank Dr U N Sinha for starting and sustaining such a wonderful academic tradition at NAL. We're already looking forward to Prof Narasimha's July 2005 lecture! /SB.

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2005

Monsoon Ragas

Professor Narasimha's birthday lecture at NAL on 20 July 2005 was built around an intriguing poser: given that the climate in the tropics is forced' to a greater degree than the climate further north in the temperate zone -- that is more driven by instabilities -- shouldn't tropical weather be actually *more predictable*?

Apparently, yes. But why, then, are we doing worse than the northern countries in weather prediction? Is it that we don't have enough observations? Or, that we don't understand the physics and the dynamics as well? Or, that we haven't tuned' the prediction software sufficiently well?

Nothing like a juicy problem to stir up our 72-year-old professor! So, the good professor goes adventuring again.

He begins his quest by attending a dance performance. He calls it the 'monsoon dance'. The performance begins with a 3D animation of the passage of clouds over the Indian sub-continent during the monsoon months of June-September 2003. After the intermission, it's the same 3D animation of the monsoon clouds for the next year, i.e., June-September 2004.

The professor plays this animation many times over to understand the plot better. Some things are immediately obvious: the clouds were significantly sparser in 2004 that fits with observation: 2004 was indeed a bad monsoon year, and 2003 was indeed much wetter.

Then he stares even harder at the imagery. Is there some discernible pattern as the clouds come dancing in from the Bay of Bengal and sail across the peninsula? Again, and again, they return they apparently dance quite the same way, and then go away.

And is there some sufficiently significant northward movement visible? It seems that there might be, but the professor isn't really sure. He could try playing with the animation speeds to get more clues but he really wishes that there were more data!

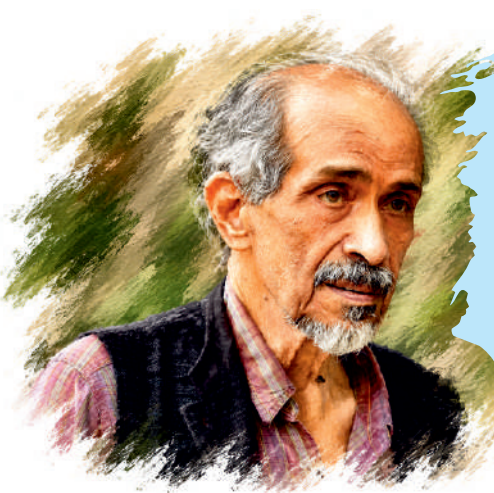
But there's certainly something in the evidence; there's already sufficient reason to believe that the behaviour in the tropics may indeed be more orderly. But if there is order, then we must be able to put a number on it.

The professor decides to confront the messy picture'. Is there a pattern? Or is it just random? He realizes quickly that it's the same question that's always asked about turbulent flows. He reflects momentarily on that old debate between fluid dynamicists and meteorologists. Is it basically a plume? If yes, can we demonstrate it?

The professor needs a tool, something like a magnifying glass that allows him to look deeper inside. Something that can separate this order' from the disorder' something that can see both the forest and the trees.

He decides to use wavelet transforms. Long before those MATLAB guys put it in, he, almost two decades ago, had recognised the potential and the power of the tool. He had even asked Dr B S Adiga and his NAL colleagues to give one of the first Indian workshops on wavelets. But that's another story.

The picture does indeed change quite dramatically after using wavelets. Suddenly hidden vortex rings leap into view: sometimes we see whorls or filaments, sometimes we don't. But there's little doubt that the picture is now a lot clearer.



"We indeed begin to see something. Not the complete symphony of the monsoon raagas itself, but the suras, at least, can certainly be comfortably spotted."

The excitement mounts. Historical evidence is unearthed (and, with it, memories of grandfather's tales about the terrible 1879 famine).

Experiments are set up. Correlations - for example, between sunspots and monsoon activity - are computed. There's almost too much data on view. The others are satiated, but the professor's rhapsody continues. He's briefly 42 years old again!

We indeed begin to see something. Not the complete symphony of the monsoon *raagas* itself, but the suras, at least, can certainly be comfortably spotted.

The final verdict is that there is indeed more order in monsoon rainfall than we have believed. We seem capable of accounting for about 40% of the variability.

The lecture ends. We almost wish that Prof Narasimha turned 73 instantly, so that we can hear his next lecture. But that's unfair. We want Prof Narasimha to savour every new day of his lifetime. And we shall savour, each day, his delightful presence amidst all of us. Happy birthday, Prof RN! /SB.

"There is indeed more order in monsoon rainfall than we have believed. We seem capable of accounting for about 40% of the variability. "



2006

The paradox in Indian Aeronautica

I remember Professor Roddam Narasimha speaking at the Bangalore air show in 2003. He seemed excited as he posed the question: “Can it be boom-time for Indian aerospace?” The general tenor of his talk that day was: “Although I’m posing this as a question, I strongly believe that the answer is yes”.

Three years later, it was again question time for the good professor. The title of his 2006 birthday lecture at NAL on 20 July was: “*Aeronautica is globalizing: Can India afford to keep out?*”. While the talk was, in many ways, an extension of his boom-time talk, the cheerful optimism had diminished. Prof Narasimha was now talking of an apparent paradox; that could be rephrased as: “When the basic fundamentals of Indian Aeronautica remain extremely strong, why isn’t that boom coming?” He wasn’t yet ready to shed his optimism, but he was clearly puzzled.

When a great mind is puzzled, and there’s little doubt that our 73-year-old is one of India’s finest thinkers, the first instinct is to examine the data and the trends. The numbers weren’t particularly encouraging. Indian science was dipping alarmingly (“even Taiwan has more engineering Ph.D.s than India!”), the gap between India and the rest of the world in RD&D was widening, the quantum of “truly innovative” Indian R&D was rather low and India’s performance indices in Aeronautica were significantly lower than even Brazil; China, of course, has streaked so far ahead that we will probably never catch up.

The picture didn’t seem particularly rosy. “We don’t seem to know how to exploit our potential and talent”, Prof Narasimha said, and wondered if the endgame would feature a Western group “exploiting our talent the way we can’t ourselves”. There were other worrying thoughts: “Why are we responding to Aeronautica scenarios as consumers? Why not as scientists and economists?” Arguing that it would be suicidal for India to keep out of a globalizing Aeronautica, Prof Narasimha’s prescriptions for the future were: (a) “integrate buy with make” (the Chinese drove a hard bargain before placing a big A320 order), (b) encourage public-private partnerships (so

that projects are driven faster), (c) aggressively grow private small and medium enterprises, (d) leverage on defence purchases, (e) join multinational projects, but always with a view to build national capability, (f) make administration more flexible, and management more dynamic and aggressive and (g) nurture tomorrow's leaders.

It was therefore another remarkable birthday effort by Prof Narasimha, although he did appear puzzled to note how long his birthday lecture series, initiated over a decade ago by Dr U N Sinha, had endured: "Aren't all of you bored of me by now?", he asked.

If one looks at the growing audience that's turning up to hear Prof Narasimha talk, it would appear that he's doomed to continue this ordeal, at least as long as Dr Sinha is around at NAL. Actually, these Narasimha lectures are now an occasion to celebrate, and to warmly applaud a gentleman of exceptional intellect and charm. They don't make professors like him anymore. /SB.

Aeronautica, Prof Narasimha explained, was the conglomerate --encompassing aeronautical S&T, civil aviation, certification, MRO, economic policies, industry, etc. etc.



2007

Science, Rationality and Intuition

The word 'Science', although commonplace in usage and apparently obvious in its meaning, becomes highly contentious when philosophers or scientists of different intellectual camps attempt to interpret it. Prof. Roddam Narasimha brought out some aspects of this debate in what has become an annual event that one eagerly looks forward to – his birthday lecture at NAL. The lecture titled “Are there different ways of doing science?” had as its premise that there are at least two ways of doing science: the Greek and the Babylonian methods. Prof. Narasimha in his characteristic understated style builds up the arguments by directly presenting the views of scientists, scholars and philosophers along the course of history.

The Greek method, he says, is one of “first principles”, or essentially an axiomatic approach. One starts with axioms or propositions that are taken as self-evident and indisputable. Then, by applying logical operations on these axioms, conclusions are derived or deduced. The emphasis here is on the consistency of the logical operations and its proof. The Babylonian method on the other hand is one of “relating one thing to another”, borne out of observation and intuition. The emphasis in this method is not on the provability of the method but rather on the validity with respect to observations. The Indian way of thinking and doing science, Prof. Narasimha insisted, is closer to the Babylonian method. He then went further to rally the two camps, and pitted one against the other, each camp led by formidable Generals: Dirac vs Feynman, Einstein vs Euclid, Hardy vs Ramanujan, Ptolemy vs Aryabhata, and so on.



“Indian texts and scholars reinforce the point that the Indian way of thinking has largely been algorithmic with the intent to be able to predict correctly. Thus, the results, in addition to agreeing with intuition, should also be validated with observations.”

The mathematician S. Ramanujan, for example, developed theorems for which there was “no strictly logical justification” and was based on a “mixture of evidence and intuition”, in the words of the British mathematician Littlewood.

Prof. Narasimha cited Indian texts and scholars to reinforce the point that the Indian way of thinking has largely been algorithmic with the intent to be able to predict correctly. Thus, the results, in addition to agreeing with intuition, should also be validated with observations. Another point made by Prof. Narasimha is that this is not strictly an East vs West issue. The Dutch mathematician (or logician, if you will), Brouwer, was guided by this mode of thought and is in fact the father of the branch of logic termed as Intuitionist Logic. The fact that he had read and was influenced by the Bhagavad Gita was an interesting piece of detail. Feynman, the great American physicist and a self-professed Babylonian, also used methods for which there was no proof that they were right, but were used nevertheless because they worked! Schwinger, who shared the Nobel Prize with Feynman, called him an “outstanding intuitionist”. Einstein was also disturbed by the certainty assumed by the Euclidean axioms.

Prof. Narasimha thus asks “how do we know what we know is right?” Is it based on proof, observation or intuition? Or a blend of these? Analyses on the philosophy, history, methodology or sociology of science are often coloured with politics, polemics or dense jargon. This lecture was a delightful exception. Also, for someone fed on mainly western fare (simply due to more accessible English translations), Prof. Narasimha's lectures possess the additional charm of providing an insight into Indian thought and culture. This lecture series has yet again brought out the eclecticism of Prof. Narasimha. Our warm birthday wishes to him! And thanks to Dr. Sinha for continuing to be the prime mover behind this series. /GMK.



“Are there different ways of doing science? There are at least two ways: the Greek and the Babylonian methods”. Prof. Narasimha built up the arguments by directly presenting the views of scientists, scholars and philosophers along the course of history.

2008

The *Yukti* of Classical Indian Science

“What does one do when one turns 75?”, I asked Professor Roddam Narasimha (RN). “Oh, I suppose one waits to turn 76 ... and one continues to do fluid dynamics!”.

RN spoke to us at the Flosolver Lab.; he was at NAL to deliver what's now simply called his “birthday lecture”. It's an event about which RN has mixed feelings: while it's always a great pleasure to return to the S R Valluri Auditorium and meet old friends, including dear old “Rao” Valluri himself, it is rather embarrassing to deliver one's own birthday lecture year after year. “Somehow or the other Dr U N Sinha and the rest of you always manage to get me here”, RN said resignedly. But it was a reticence that no one else in the packed auditorium shared; in fact, the lecture evoked great excitement and curiosity. “I'm sure Prof RN will, as always, have something new and astounding to tell us”, NAL Director Dr A R Upadhyaya predicted as he welcomed his illustrious predecessor.

RN's lecture, titled, *The Yukti of Classical Indian Science*, started with the intriguing poser: Have you ever wondered why all the science that we learn and practice seems to have originated in the West? Why do our textbooks talk of Newton, Faraday or Gauss, but not of Aryabhata, Brahmagupta or Madhava? Why is it that the distinctly modern scientific revolution occurred in Europe, and not in India or China? Why, as Joseph Needham asked, did the science of Galileo emerge in “Pisa but not Patna or Peking?” Was there ever a truly Indian science?

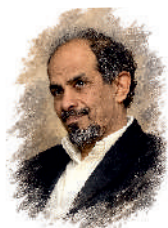
Till about 1600 or so (“till Newton came along”), and for the best part of 14 centuries till then, Indian and Chinese science was actually ahead. But then something went terribly wrong; it was almost as if an entire past was mysteriously wiped out.

In an enthralling lecture, RN discussed the likely reasons for the abrupt demise of the golden age of Indian science some 400 years ago. The 'foreign invasions' hypothesis doesn't particularly impress RN; the hypothesis that India's caste system may have caused it doesn't win RN's favour either. “It's

really more to do with how Indians did science, about what Indians thought of science ... and in my readings of the history of Indian science there's one word that keeps cropping up: *Yukti*." *Yukti* is about putting things together, about unifying, about skilful and ingenious practices ("smart ways" in today's *lingo*). *Yukti*, RN argued, was always Indian science's underlying paradigm. While the European method was based on hypotheses, generalizations, deductions and abstraction, the Indian method was based on observation, examination and ingenious specific solutions or inferences. What was 'proof' for the Greeks was '*yukti*' to the Indians.

With *yukti*, Indian science took impressive strides: it was possible to combat disease, make accurate astronomical calculations, calculate the surface area of spheres, do interpolation and calculus, and even be the first to prove the Pythagoras theorem. But 'general' questions were rarely posed, and solution ideas were never taken to the limits. So, when Newton triggered off the West's inexorable wave of learning and scholarship, Indian science was overwhelmed and eventually completely submerged. The fact that, till 1700 or so, the East in general was strong and prosperous, the status quo was comfortable, and there was no great internal pressure to change the global order, must also have contributed to hasten the demise.

It was therefore another brilliant and enjoyable RN lecture, and, seeing his continuing good form, it's easy to predict that NAL won't let RN get away from these birthday lectures; there have already been over a dozen, and each one has been a rich and delightfully fulfilling experience. Indeed, these lectures offer a wonderful opportunity for NAL and Bangalore to celebrate the eclectic ingenuity of Roddam Narasimha, and to applaud one of India's greatest scholars. He's 75 now and complains that he's becoming "a little less effective now". But that's merely the modesty of the man; the modesty that always accompanies the truly great. We shall wait for RN's next lecture ... we shall wait to be again charmed and captivated. Till then ... get on with your fluid dynamics, professor! /SB.



"Have you ever wondered why all the science that we learn and practice seems to have originated in the West? Why do our textbooks talk of Newton, Faraday or Gauss, but not of Aryabhata, Brahmagupta or Madhava?"

2009

Flying High on RTA Wings

For many of the old timers in NAL, July 20 is eagerly awaited. It is not that we get our increment or so. It happens to be Prof. Roddam Narasimha's (RN) birthday. Thanks to Dr. U. N. Sinha, this day is when Prof. RN is compelled to feed NAL staff with a technical cake. Year after year, Prof. RN has fed us well. Cakes have always been very different each time. This time it seemed like a bigger cake well suited to the taste of NAL since Prof. RN chose to speak on "New wings for New Turboprops".

Introducing the problem, he said that the turboprops have some great advantages which we could afford to ignore so far owing to low fuel costs. But no longer ... since the fuel prices have started to rise. Since the 1990's, there has been a drop in the use of turboprop aircraft due to cheap oil, high cabin noise and more flying into turbulent weather. There is also a general perception that jet aircraft are "safer" which, in reality, is not so. Jet aircraft also enjoy some sort of status symbol. But they are pricey and consume lot more fuel. For instance, an ATR-72 on a 370 km (200 Nm) sector consumes less than 40% fuel and emits 50 % less CO₂ than an equivalent jet.

Prof. RN has been involved in the NAL's RTA project in many ways. On many occasions he has spoken about it with a lot of passion. He has thought very deeply about it and now has taken up a project on developing new optimized wings for the proposed new turboprop aircraft that NAL intends to build, viz., RTA-70. During this talk, he presented the details of this work. His idea is to exploit the propeller slipstream energy for better wing design.

The approach is to use a simple theory to understand the basic physics. He said that there is generally no need to jump to complicated tools or theories. The present work makes use of a simple lifting line theory to model the wing.



"Turboprops have some great advantages which we could afford to ignore so far owing to low fuel costs. But no longer ... fuel prices have started to rise significantly!"

This wing is assumed to be immersed in the wake of the propeller which is estimated using CFD. He presented the details of the classical lifting line theory modified to take into account the slip stream effect. The problem is then solved numerically using the standard collocation method. The wing itself is parameterized using Bezier curves. Slightly digressing, Prof. RN gave a brief introduction to the Bezier curves and said that they were first employed to design fonts.

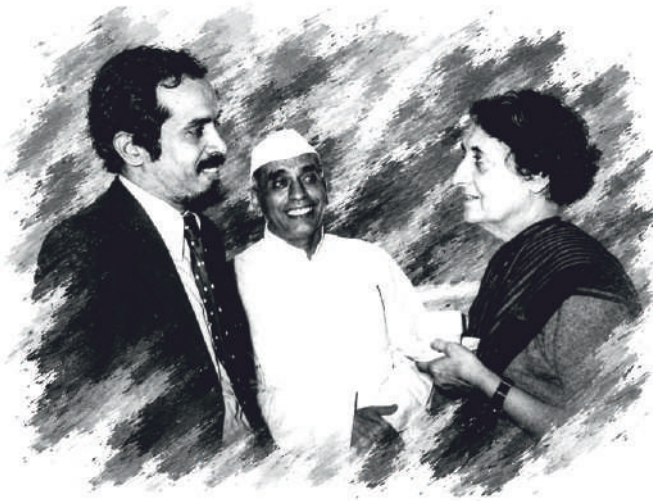
He then presented some sample results. In some cases, the reduction in induced drag could be as high as 37%!! Some shapes looked very unusual. Some even looked almost like Batman's cape! But they all made physical sense. Prof. RN said that the shapes need to be examined further using tunnel experiments or high fidelity CFD simulations. More practical constraints need to be brought in, such as structural constraints, engine integration, fuel tank volume etc. However, the present methodology is fully established. There were many questions from the audience. Some were unable to believe that such wings could exist. Some appreciated the idea. Prof. RN went about his usual way of answering the questions with great clarity. We learnt more during this session as well. Thank you, Dr. Sinha for making this happen, year after year. /VYM.



Some shapes looked very unusual. Some even looked almost like Batman's cape! But they all made physical sense.

2010

Complete the Circle?



There is a story from the 1970s – not apocryphal – when Prof R Narasimha, asks Prime Minister Indira Gandhi why she didn't support national *aeronautical* programmes in the country when she was so enthusiastic of the national *space* programme. “I would”, Mrs Gandhi replied, “if all of you spoke in one voice.”

That's why the creation of the National Civilian Aircraft Committee (NCAD) has generated so much excitement. All stakeholders in Indian civil aeronautics are represented on the Committee and – better still – NCAD, chaired by Mr G Madhavan Nair, is an 'empowered' committee; so, the agencies involved will not have to go running to Delhi every week to get approvals! “This is an extraordinary step in Indian aeronautics. We couldn't have asked for more!” exclaimed Prof Narasimha, who is himself a member of NCAD and, at 77, is probably the 'wise old man' on the committee.

I speak figuratively of course because, although he has always been wise, it is hard to think of Prof Roddam Narasimha (RN) as someone old. The years are rolling by, but there's hardly anything RN can do about that. But what he can do is continue showing the same infectious enthusiasm, and unbridled optimism, for India and Indian aeronautics.

We saw glimpses of that enthusiasm and optimism as RN turned up to deliver his 'birthday lecture' at NAL on 28 July 2010 on *NCAD: The Next Major Challenge for NAL*. This birthday lecture programme was initiated by Dr U N Sinha over 15 years ago and is now inextricably wound into NAL's fabric. "I was hoping that after Sinha retires from NAL this lecture business would end", he remarked, "but that doesn't seem to be happening!" It won't, because this lecture programme is an occasion for all RN admirers to assemble; and marvel at the wit and wisdom of this exceptional engineer and philosopher. You don't squander such opportunities! It was therefore no surprise that NAL's S R Valluri Auditorium was overflowing long before the lecture commenced.

RN began by pointing out that, being the country's only national civil lab in aeronautics, NCAD would become the biggest game-changer for NAL. "It's going to be an extraordinary challenge for NAL ... they must learn how to make and ride this approaching wave." He then proceeded to list NCAD and NAL's many formidable challenges ahead: *different ball park* ("and very different from the defence projects NAL is used to"), *huge stakes* (need to compete internationally), *seek commercial success* (to sell, the new aircraft must be perceived as having international quality), *work with private industry* (and exploit public-private partnerships in a radical restructuring), *grapple with manufacture, operations, certification* ("manufacturing in huge numbers is a completely different ball game"), *understand finance* ("aircraft are not sold just by performance, but also by attractive financial terms"), *change staffing patterns* ("we must find new methods for hiring") ... and achieve all this without destroying NAL's basic R&D culture and fabric.

To most this might seem an insurmountable task, and a bridge too far. But RN doesn't think so. "All major aircraft development programmes were born in R&D labs, because knowledge basically resides here", he reminded the audience, "but then they moved away." And RN continued: "Just see our advantages.

"All major aircraft development programmes are born in R&D labs, because knowledge basically resides here But, later, they move away."



We have low-cost RD&D, a large market, an incredible human resource pool ... there is something special about Indians; we don't realize this ourselves, but the rest of the world sees it clearly!"

And then RN got excited by the R&D challenge. "Should we go for a turboprop or a turbojet? People think propellers are old-fashioned, but so much has happened in the last two decades. Could an ultra-modern turboprop be the answer? It is such a wonderful opportunity to regain the R&D advantage India enjoyed a decade ago when LCA-related technologies bloomed. We've conceded ground in the last decade, but we could bounce back!"

Seeing the good professor's passion and fervour took me back by two decades and more. I can still visualize a 55-year old RN showing charts and curves to assert that Indian civil aviation is poised to explode (no one quite believed him then, but see what's happened today), talking to MDB, Russia, about collaborating on a light transport aircraft (but then the Soviet Union collapsed), being bullish on composites, barely curbing his exultation when Rustom Damania's team flew the LCRA ... and, a decade later, foreseeing India's approaching aeronautical boom (but warning that we'll miss the bus if we don't play it right ... and we didn't!). / SB.



"Just see our advantages. We have low-cost RD&D, a large market, an incredible human resource pool ... there is something special about Indians; we don't realize this ourselves, but the rest of the world sees it clearly!"

2012

Next Gen Turboprop

NAL is young again with more than 250 Scientists B's and C's making up bulk of the manpower. So, for them, the RN Birthday Lecture would not have meant much. At least I thought so. To my surprise, I found the S R Valluri Auditorium packed on 20 July 2012 to hear our 79-year-young Professor Roddam Narasimha, RN to most of us, deliver his lecture on *"Next Gen Turboprop. Why an Indian PP Initiative in a Global Venture Makes Eminent Sense"*.

A lecture has always been RN's birthday gift to NAL ever since he retired in 1993 and this was the eighteenth. Prof. RN had spoken about civil transport aircraft on earlier occasion. He had also advocated turboprop. But the decision by the High Powered Committee set up by CSIR-NAL for its regional civil transport aircraft was to go with turbofan instead. Prof. RN being a member of this committee had also concurred. He said so in this lecture. Naturally, I was apprehensive as to why Prof. RN has started talking about turboprop again. But after hearing him full that I understood he had a point and data to support it. Prof. RN said that the aeronautics situation in India is really bizarre!

There has been an increase of 17.6 per cent in air traffic during January and November Yet, only one airline was profitable. One is on the brink of bankruptcy. India levies 50 per cent direct operating costs while elsewhere it is only 30 per cent. In spite of India being third largest aircraft market, there is no Indian civil aircraft. China on the other hand has the third largest civil aircraft industry next only to Boeing and Airbus! China invests 50 Lakh crore rupees in aeronautics. India invests merely 10,000 crore rupees. The numbers Prof. RN showed were revealing and sometimes mind boggling. I think they underline many things by way of policy in India. The message has to be seriously taken note of by the aeronautics community of this country.



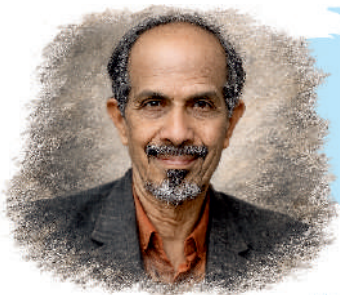
"Cheaper, greener, quieter'. Future aviation must be environmentally responsible."

He then went on to look at the Turboprop aircraft scenario. He listed five very successful aircraft including Antonov An-140, Xian MA60, Ilyushin Il-114, DHC Dash 8 (Bombardier Q400) and ATR. Of these, ATR 72 has been the most successful. But there are five major contenders in the turboprop category with recent designs. We must admit that we cannot surpass them.

Arguing his case, Prof. RN said that turboprops are inherently more efficient. For instance, ATR 72 consumes 40 per cent less fuel and emits 50 per cent less CO₂ over a 370 km journey. He said that design philosophy has also changed resulting in a new relationship between the engine and airframe manufacturers. Earlier it was one of vendor-customer relationship. Now it has shifted to one of partners resulting in an integrated engine-airframe design. As a result, Pratt & Whitney is now developing a new SHP turboprop engine for 100 pax aircraft. Prof. RN also took us through some Turboprop facts. Again, these were revealing. Europe and Asia have the highest number of turboprops. Asia is the biggest market. It is only in the USA that the equation is reversed. This is perhaps owing to historical reasons. It is interesting to note that ATR would be launching 85 seat turboprop aircraft in 2014.

Prof. RN said, again in favour of turboprops, that the new mantra would be "Cheaper, Greener, Quieter". Future aviation will be environmentally responsible. He observed that it will be low fuel, low fares and iPad entertainment. He quoted targets being pursued by Next Gen aircraft designers, 20 per cent less fuel consumption being an important one among them.

Before asking a series of serious questions, Prof. RN put out some conclusions saying that regional low-cost aviation is waiting for the right aircraft.



"Turboprops, with a range of 300-1000 km are ideal for Asia; but less so in Europe with highly competitive rail transport. India and Asia need an aircraft with a range between 1000 to 1500 km that is economical, comfortable, novel and with green appeal."

Turboprops are ideal for Asia over 300 to 1000 km range whereas in Europe it is not so owing to highly competitive rail transport. He said that what we need is an aircraft with range less than 1000 to 1500 km that is economical, comfortable, novel and with green appeal. Marginally higher speeds are not desirable anymore. Prof. RN then asked, "Why Indian Initiative"? He said that India has large inter-city pairs, air traffic is on the rise, manpower costs are low, market is sensitive and above all IAF can be a launch customer. Next question: "Why P and P"? Answer: HAL is overloaded, good business opportunity for private players, IAF prefers to work with private industry, Planning Commission advocates PPP. Of course, civil aircraft has to be a commercial success which is a key point. He went on to ask "Why Global"? To this he said, commercial success necessarily implies a large market, Indian industry has no brand name therefore requiring foreign branding. More importantly, Indo-x will be more robust and will have quick access to relevant technologies. There was one last question: "Why Initiative from India"? It is essentially because we have a huge market which is growing and there is sufficient aeronautics talent that has been nurtured by the Government since a long time. It was interesting that this lecture was not just an academic exercise. Though he spoke about his research on new turboprop wing designs that take advantage of propeller slip stream from a very technical perspective, which I am pretty sure is his pet project these days, throughout the lecture he spoke with conviction about the need for new turboprop regional aircraft for India and amply supported it by data. He ended his lecture by delineating the "next steps": Try new wings, make preliminary design, invite global partners, share risks and profits and, true to his nationalistic spirit, which I have now known for a while, he said, make it a national flagship project. The lecture ended with well-deserved applause and the program ended with the National Anthem, that has been a great tradition reintroduced by NAL in recent times. VYM.



"Indian industry has no brand name; it therefore requires foreign branding. We must also make Indo-x more robust, and help gain quick access to relevant technologies."

