

**DOWN MEMORY LANE**

Reminiscences

**A Tribute to Dr VS Arunachalam**

*Released on the occasion of the conference*

**An Indian Century:  
Science, Technology and Policy**

Defence Metallurgical Research Laboratory, Hyderabad

October 28-29, 2005

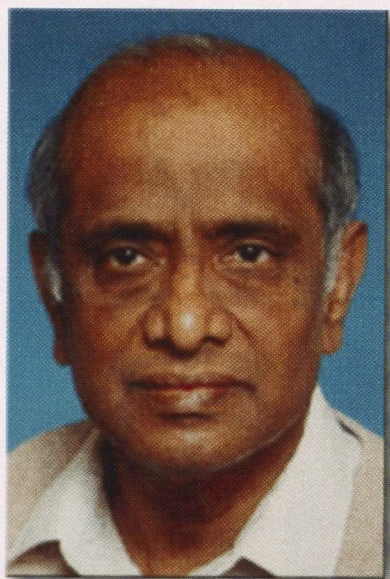
*held in honour of*

**Dr VS Arunachalam on his 70<sup>th</sup> birthday**

The relationship between national policy and various facets of science and technology was the broad theme of this conference. This theme has occupied a significant portion of Dr Arunachalam's distinguished career, and is an interest that he continues to engage in with passion and commitment to this day.

This booklet contains reminiscences of a few people recounting their interactions with Dr. Arunachalam over the last five decades

B. Sc. (Mysore University)	1956
M.Sc., Physics (Saugar University)	1958
Ph.D., Materials Science (University of Wales, UK)	1965



D. Sc., Honoris causa, Devi Ahalya Indore University, 1987

D. Litt., Honoris causa, Annamalai University, 1989

Dr. Eng., Honoris causa, Roorkee University, 1991

1959-70	Scientist, Bhaba Atomic Research Centre (BARC), Trombay
1970-72	Visiting Scientist, Aerospace Research Laboratory, Wright Patterson Air Force Base (WPAFB), Ohio, USA
1972-75	Assistant Director, National Aeronautical Laboratory, Bangalore
1975-82	Director, Defence Metallurgical Research Laboratory, Hyderabad
1982-92	Scientific Adviser to Raksha Mantri, Secretary, Dept. of Defence Research & Development, and Director General, Defence Research & Development Organisation (DRDO)
1992-94	Senior Visiting Professor, Materials Science & Engineering, Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, USA
1994-current	Distinguished Services Professor, Engineering and Public Policy, Materials Science & Engineering and The Robotics Institute, Carnegie Mellon University, Pittsburgh, USA
2002-current	Founder, Center for Study of Science, Technology and Policy (CSTEP), Bangalore
2004-current	Vice Chairman, State Planning Commission, Tamil Nadu

### ***Materials Science & Engineering***

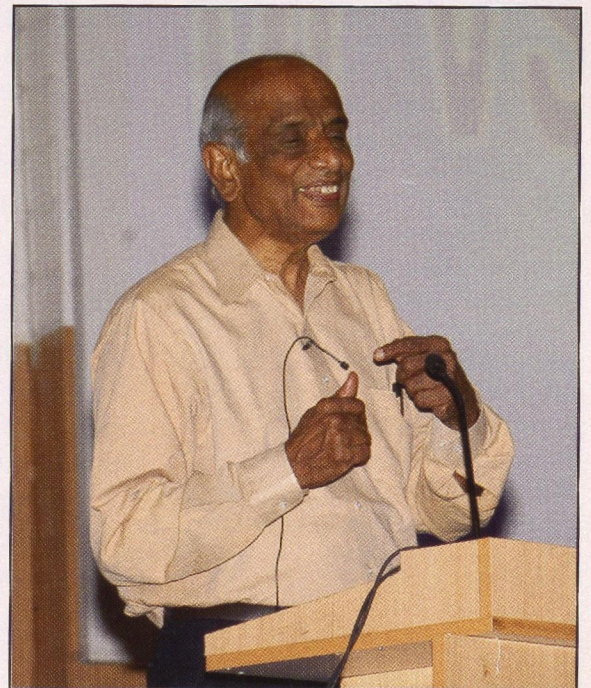
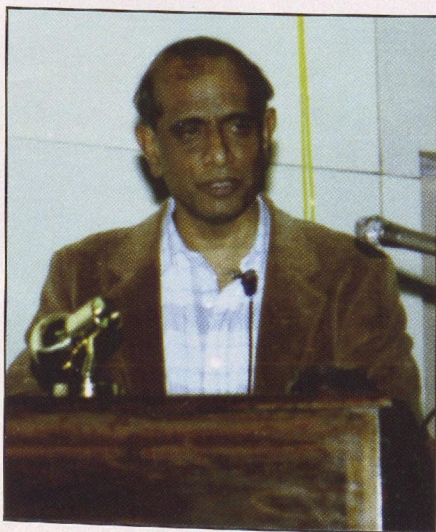
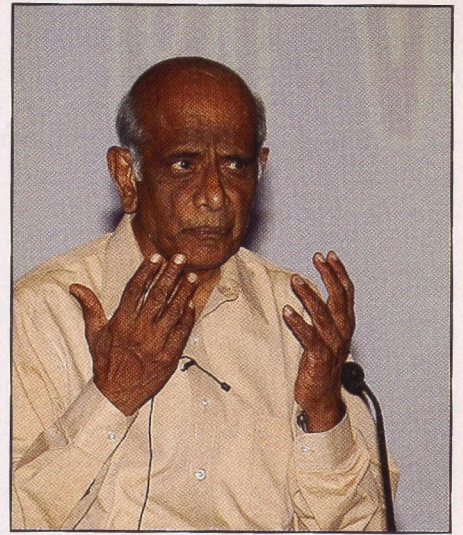
Integrated materials design; densification of powder preforms; dislocation structure and mechanical properties in intermetallics

### ***Information Technology***

Light wave communications and fiber-to-home technologies for IP; IP based enabling technologies for education and economic growth. Global software industry, their classification and contributions.

### ***Engineering and Public Policy Issues***

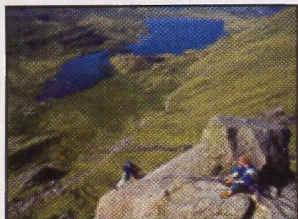
Studies on infrastructure technologies and policy issues in newly growing economies; Electric power issues in India with a focus on alternate energy options including biomass based electricity generation. Technology and national security.



# Notes concerning a long-lasting relationship

Robert Cahn

6 Storey's Way, Cambridge CB3 0DT, England.



**School of Informatics**  
University of Wales, Bangor



## The Annual Engineering Lecture

*The Annual Engineering Lecture, organised jointly with the IEE, was delivered in October 1996 by*

*Professor VS Arunachalam, Distinguished Services Professor at the Carnegie Mellon Institute, who chose as his subject "Beyond the Industrial Revolution". It*

*was a pleasure to welcome Arun back to Bangor where he had studied for his PhD. His career eventually saw him elevated to Chief Scientific Advisor to several Indian Prime Ministers before moving on to his current position in the USA.*

extracted from the annual report  
1996-97 (<http://www.informatics.bangor.ac.uk/public/general/>)

Arun had arranged, in early 1962, while he was working in Trombay, to come and work with me as a doctoral candidate at the University in Birmingham in England. He knew of my work on twinning in uranium and also of my editorship of the Journal of Nuclear Materials and so I must have seemed suitable to him as a doctoral supervisor. Soon after that arrangement was made, I was offered a chair at the University College of North Wales, in the small town of Bangor, and by the time Arun arrived in October, I was dug in at that new location. I had some American research money to finance him; the research was to be in physical metallurgy. There was the slight problem that the Welsh university department which I had joined was focused on semiconductors and other 'electronic' materials, but I did not allow this small complication to alter my plans for Arun.

Arun's research involved growing single crystals of CuAu and then examining the effect of small, elastic stresses on the morphology of ordered domains. The idea had grown out of research I had done with another alloy not long before. Arun took just a little while to learn to make things, and conduct experiments, with his own unaided hands, but once that was achieved, he never looked back. He adjusted with impressive speed to the idiosyncratic world of the Welsh (though I don't believe that he made much progress with the Welsh language, which is at least as difficult as Sanskrit) and made a number of good friends among colleagues with interests totally different from his own. That is an enviable gift which he has retained.

Arun was my first Indian research student and I quickly learnt about one or two peculiarities: the principal one was his habit of shaking his head (as it seemed to me) when he meant 'yes'. We sorted that out rather quickly. He charmed my little daughters with his blackboard drawings of elephants and other creatures, and he gave them minute ivory elephants contained in a hollowed-out seedpod; they still remember the experience with pleasure. I believe that it was during his time close to the beautiful mountains of North Wales that he came to share my taste for mountain walking that, years later, led us to undertake two Himalayan expeditions.

At the end of 1964, I moved again, to the new University of Sussex in the south of England. Arun had just finished his research (in record short time) and was writing his thesis. When the draft was finished, he came to spend a few weeks in Sussex; his thesis was typed there and he then waited for the examiners to read it and for his oral examination. To fill that time for him, I arranged for him to visit an atomic energy laboratory in Stockholm, Sweden, with which I had contacts. I believe that he still maintains connections there. On his return he successfully completed his oral examination.

Arun returned to India and began his steady rise to positions of increasing responsibility and influence. He soon began to feature on a

world stage as well as on the Indian scene. Arun and Meena kept steadily in touch with my wife Pat and me, especially after my first visit to India in 1972. During that visit I got used to the ubiquitous Ambassador cars and the need to shout on long-distance telephone calls – two features which no longer apply. Other features, such as elephants and buffaloes on major roads and green coconuts for refreshment can happily still be seen. Pat and I visited DMRL and later his immense office in New Delhi, and through him I met numerous eminent and interesting Indians. At the time, I had a young Tibetan refugee protégé and Arun, though overworked, was not too busy to help him in various effective ways.

When my wife and I moved to Paris in 1981, Arun arrived one day at our apartment building in a splendid car with several motorcycle outriders. He invited us to his formal dinner with various French military high-ups who felt distinctly ambiguous about having a couple of unknown English people sipping their wine. That was very satisfactory.

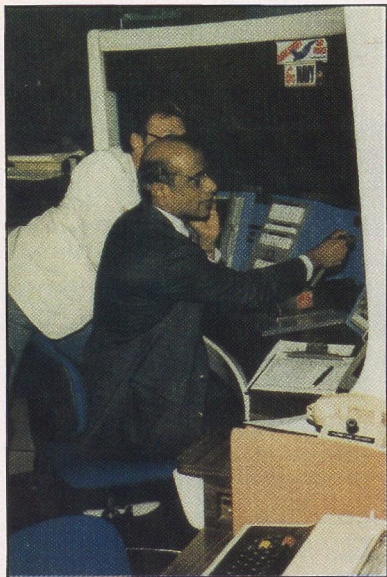
In 1979, and again in 1995, Arun and I and our wives (and on the first occasion also another Indian ex-student of mine, Manu Bhatia, and his wife) went trekking in the Himalayas – the first time from Manali over the Rohtang Pass to the Bara Lacha La at 16000 feet, the second time in Sikkim to near the foot of Mt. Kanchenjunga. Both occasions were splendidly exciting, and we made our first acquaintance with the ubiquitous yak.

We received various visits from Arun and Meena at our successive homes in England and on one occasion we took them to see a performance of Shakespeare's 'Julius Caesar' in Stratford. Arun found to his slight surprise that chicanery in public life has not changed much since Roman times. In 1992 or thereabouts Arun and Meena moved to Pittsburgh for a while and started yet another chapter in their adventurous lives, and we visited them there on a number of occasions. We also exchanged a steady stream of our respective publications. Now it just remains for us, if and when I am fit enough, to see their latest dwelling in Bangalore.

Our friendship for the last 43 years has been one of the most satisfying experiences of my professional and private life. It just remains for me to wish Arun many happy returns on the occasion of his 70th birthday, and to say how sorry I am that I cannot be present in person!



Dr VS Arunachalam with colleagues from DRDO,  
Dr D Banerjee (on his right) and  
Shri KVSS Prasad Rao (on his left).



## Arun at NAL

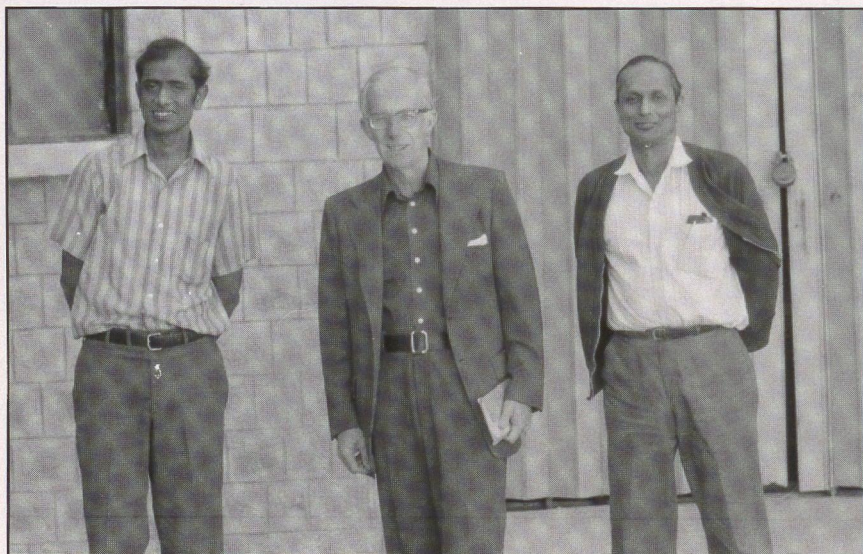
RV Krishnan and AC Raghuram  
formerly at the Materials Science Division,  
National Aerospace Laboratories, Bangalore.

Dr VS Arunachalam joined the National Aerospace Laboratories (NAL) in 1969, at a time when a major decision was taken at NAL to expand the activities of the metallurgy group. Dr. Arunachalam was entrusted with the responsibility of formulating various programmes. In a sense, that heralded the beginning of the thrust in research and development in metallic materials. He initiated major activities in the areas of titanium metallurgy and laid the foundation for powder metallurgy of titanium alloys. He brought with him the vibrant R&D culture of BARC and enthused his young colleagues to excel in their work. Some of these activities had to be altered later because of developments elsewhere. It was during this time that he felt the need to address the recurring problems of component failures in our defence services. What started as a trickle of activity then has turned out to be a major emphasis in the later years in that NAL has come to be recognised as a major centre for carrying out failure investigations.

He left NAL in 1975 to become the Director of Defence Metallurgical Research Laboratory (DMRL) at Hyderabad, which was the stepping stone for many important positions he held later.

Dr Arunachalam endeared himself to everyone in the group through his hard work, readiness in sharing the responsibilities and credits and his willingness to fold his sleeves and work with his colleagues in carrying out experiments. He would even help repair vacuum systems and clean diffusion pumps. He encouraged students from educational institutions to freely discuss with him and his colleagues and provided free access to them to carry out experiments in the facilities available in the division. His greatness is in being close to his colleagues. He never believed in anyone calling him 'Sir'. He is 'ARUN' to one and all.

While his stay in NAL was very brief (made briefer because of a foreign assignment at the Wright Patterson Air force Base, Dayton, Ohio in the interim), he made lasting contributions, whose value we are realising even now, long after he left NAL.



With Prof Muller and Prof Ramaseshan at NAL

# Memories of VS Arunachalam

Loren A Jacobson

Lt Col USAF, Retired

Technical Staff Member, Los Alamos National Laboratory, Retired

I first met Arun in 1971 when I moved to Yellow Springs, Ohio, and we carpoled to work at the Aerospace Research Laboratory at Wright-Patterson Air Force Base. During that time we became close friends, as we shared mutual scientific and cultural interests for over a year. Arun drove an older Buick, a large and rather ungainly vehicle, and typically he drove rather fast for the back country roads that we used for our commute. One time I asked him if he wasn't driving too fast for the road condition and he told me, "Don't worry, Jake, Brahmins never have accidents." On another occasion there had been some snow, leaving a small amount on the road, and Arun came up to a curve at too high a speed. When he put on the brakes, we simply slid off the road, so I questioned him about not having accidents. His reply was, "Well, we didn't hit anything, did we?" He simply backed the car onto the road and we were on our way once more.

This supreme confidence carried over to other arenas as well. Some years later, perhaps in 1980, I was stationed in Washington, D.C. and on several occasions Arun visited our capitol in order to meet with high level officials. By that time he was Head of Defence Science in India, and usually met with his U.S. counterpart. After one of these meetings, probably with the U. S. Secretary of Defense, Arun and I had dinner together. Arun told me that he had requested the U.S. to license some advanced technology to India, I think it was related to new types of infrared detectors, and the U.S. official told him that this would not be possible. Arun then told me that his reply was, "Well, Mr. Secretary, you have given me the incentive to go home to India and develop this technology ourselves." I have no doubt that he did just that.



With Jacobson, Lipsitt,  
Williams and Blackburn  
Gordon Conference, 1989

I once asked Arun how long he was planning to stay in his post as head of Defence Science. His reply was, "Jake, let me quote you an old Tamil Proverb: When you are riding the back of the tiger, you do not get off!" On another occasion, Arun asked me how long a high level official had been in his job. I said that it was now over ten years time. Arun looked at me intently, as we all know he can do, and said, "Oh, that is much too long, because after ten years you start to believe your own B.S."

A few years later, I was working at Lawrence Livermore National Laboratory in California, and Arun visited his sister who lived in a nearby town. I was very honored to be invited to dinner, attended by over 20 people, and I was the only non-Indian. Most of the men, including his brother-in-law were working in high-tech jobs in Silicon Valley. Every once in a while, Arun would disappear, and on several of these occasions I noted that he was engaged in intense conversation with one of the other men. Later, I asked Arun what was happening, and he told me that one of his important missions on visiting the U.S. was to recruit Indian scientists and engineers to return to their homeland.

In 1995, or thereabouts, I was working at Los Alamos National Laboratory, and the director at that time, Siegfried Hecker, asked me to invite Arun to Los Alamos to present a Director's Colloquium, which Arun graciously accepted. He delivered a talk on one of his favorite subjects, the invention of lost-wax or investment casting in India, some 2000 years ago. The title of his talk was, "From Temple to Turbine." I picked him up at the airport in Albuquerque, and on the way to Los Alamos we stopped in the town of Bernalillo, where we had lunch in a small New Mexican restaurant. As we were ordering, the waitress gave us a warning about the hot chili that they were serving that day. Arun replied, "Madam, you are dealing with a person from South India, where I am sure that the food is much hotter than you are serving here." And on a similar theme, on my most recent visit with Arun and Meena in Pittsburgh, I was asked to serve as the Anglo "taster" for the Indian food they were planning to have a local restaurant cater for their daughter's wedding. They told me that if the food was not too spicy hot for me, then the rest of their non-Indian guests would probably find it palatable. There are, of course, many more very entertaining "Arun" stories that I could include here, but they would take up too much space.

**In New Mexico, all non-Hispanic, non-Native people are called by the generic term "Anglo"**

*I will add a few more words, however, to express my gratitude for the privilege of calling Arun my friend. He is, without any doubt, the most remarkable person that I have ever met. He is a true citizen of the world, comfortable in any culture. He knows more about Western music than I will ever know about Indian music. He knows more metallurgy than many Professors in renowned educational institutions. He has worked in the forest as a woodcutter and as a researcher in defense and nuclear laboratories. He has held many important posts in India, and a Visiting Professorship in the U.S.*

In conclusion, I wish Arun the best of health on the occasion of his 70<sup>th</sup> birthday, and that he should have many more birthdays. And, since behind every successful man is a very special woman, I am sure that Meena will be sharing in the accolades associated with this significant occasion.

# A tribute by a tributary

T Balakrishna Bhat  
DMRL, Hyderabad

Dr VS Arunachalam is, at the core, a scientist, but one who blossoms and transforms into a technologist and leader and from one to the other with ease. He is a philosopher, guide and a passionate friend to whoever comes in true contact with him. He is a nationalist and a universalist in the broadest sense. He loves the whole world and has world-wide personal connectivity. But wherever he may be, Dr Arunachalam has India and only India focussed foremost in his mind.

I had the good fortune of being Dr Arunachalam's student in 1972 during my ME days in the area of Powder Metallurgy and during the project work on effect of dispersoids on order - disorder transformations. Later, I did my Ph.D. on the effect of second phase on microstructural evolution and properties under his guidance. We discovered that dispersoids can interact with interface dislocations by which they can affect even oxidation, introduce threshold stress to creep, and that there is a major difference between coherent and incoherent particles. We also discovered that particle sliding is a major and crucial mechanism for successful hot isostatic pressing. Later, in the area of product development, we discovered many exciting principles and materials that today make the Kanchan Armour. I am personally grateful to Dr Arunachalam for making my research life truly exciting and for giving me a passion which has stood by me to this day.

Dr Arunachalam is always fond of ideas and shows a childlike enthusiasm especially towards ideas in the area of his current interest.

An important area of policy is human wealth and the process of education for nurturing it. The process of standard education today lays excessive importance on bookish knowledge. This actually retards growth of practical and innovative skills as well as of emotional intelligence so essential for full unfolding of the human potential. This problem can be overcome by introducing a parallel on-the-job, off-the-school, training, assessment, and reporting scheme right from Class 1.

Important is health, the approach to which cannot be primarily through medicines and hospitals. It ought to be through physical work, exercise, yoga and good food - non-junk food. Crippling medical treatments (such as heart operations and unnecessary operations to deliver babies which together cost the nation a whopping Rs.8.5 lakh crores annually due to their long term crippling effects) should be avoided by all means.

Then there is a principle of complementarity or reciprocity. If business and merchandise should be allowed to move freely, then either people or at least technologies should move freely without restrictions. Otherwise, weaker ones will be sucked to starvation without any alternatives.

Ultimate security, or the lapse of it, is in the area of genes, not only of human diversity but also all other forms of life. By freely distributing well described samples of these, under the pretext of genome mapping, cooperative research, cell research, homeopathy treatment and so on, one makes oneself vulnerable to terminator and all forms of directed disease attacks. The way to safety in this area is not to freeze to death but to insist on securing reciprocal samples. Yet another relates to personal security against diseases such as AIDS. Best approach here is universal testing. People would then easily know how not to receive and how not to spread.

Every atom of DMRL has a special affection and regard for Dr Arunachalam. Dr Arunachalam created that 24/7 excitement and research culture in DMRL decades ago. DMRL launched major materials programmes in the areas of powder metallurgy, gas turbine materials, structural materials and armour materials which transformed DMRL into a world class materials laboratory. The brake pad technology opened the eyes of the world to DMRL and our own eyes to our capability. DMRL's single crystal high temperature blades, newer high temperature alloys, aeronautical grade titanium, multi-hit resistant Kanchan Armour, super hard armour steel are equal to the world's best in their class. HIP, ETC, ATC, HAPP and ARCI and Lab School, owe much to his vision. Moving to Delhi, Dr Arunachalam kindled similar changes in the whole of DRDO.

**To narrate a bit of the  
Kanchan Armour story**



Examining the skeleton of the first Kanchan Armour with Gen Sunderji and the author

*Prof MGK Menon, the then Scientific Advisor, after witnessing the Chobham armour trials in England, entrusted Dr Arunachalam, the then Director, DMRL with the mighty challenge of developing an equivalent Indian armour. Dr Arunachalam spread his great excitement to young scientists like me and enabled DMRL to conceive and develop equivalent world-class Kanchan Armour which we now find works by disturbing the jet and by breaking projectiles into invisible particles. The related materials and modules emerging out of this research that Dr Arunachalam initiated have now gone into all Indian fighting vehicles such as MBT Arjun, T-72 Ajeya, Abhay, and many light vehicles as well as helicopters such as Lancer. More than Rs. 800 crores worth of these strategic materials have been produced indigenously. Based on Dr Arunachalam's vision, we are now setting up the Armour Technology Centre at Devatalagutta. I wish to thank him especially for this.*

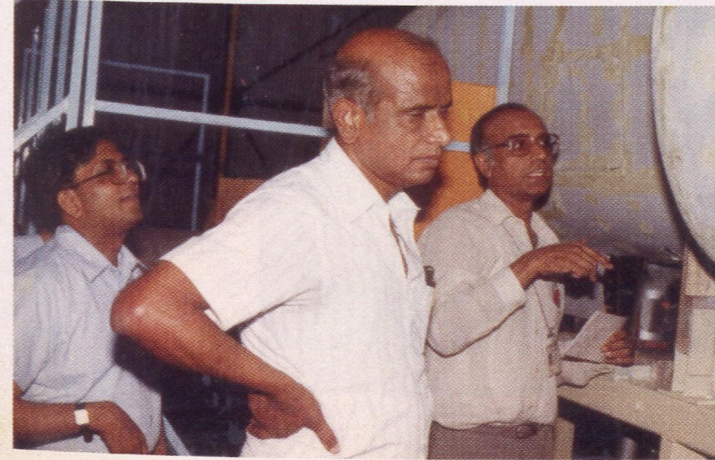
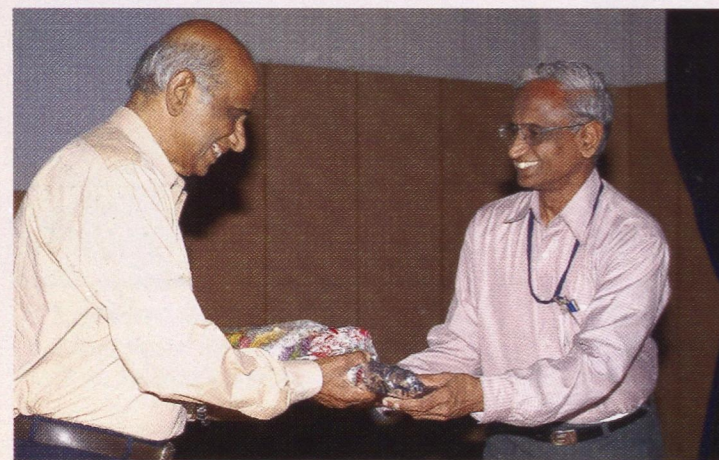
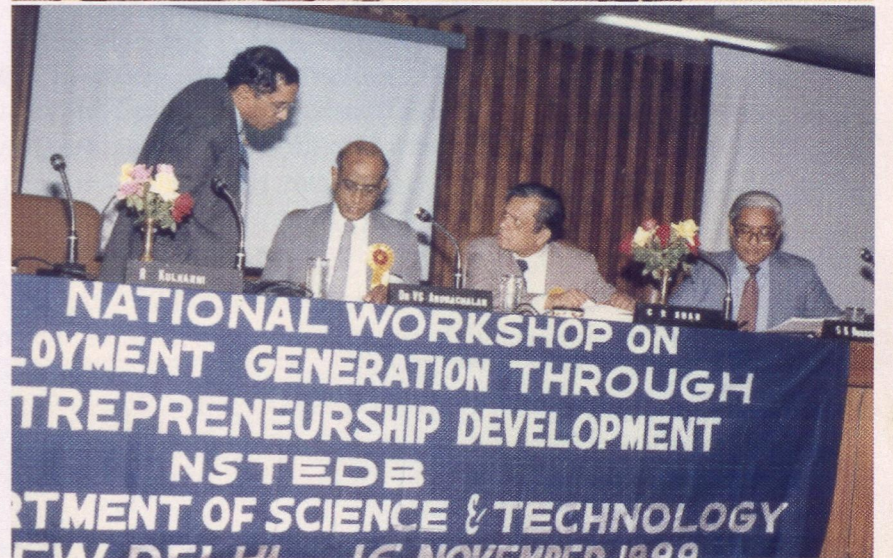
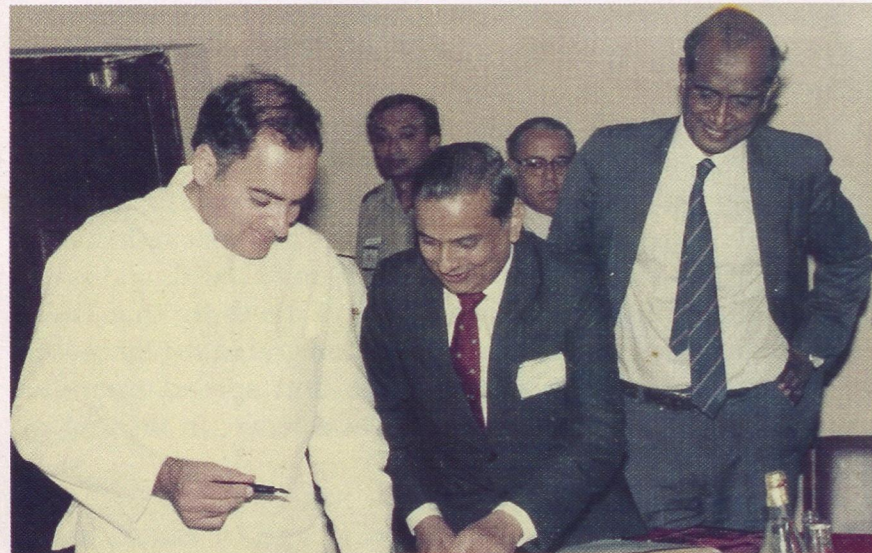
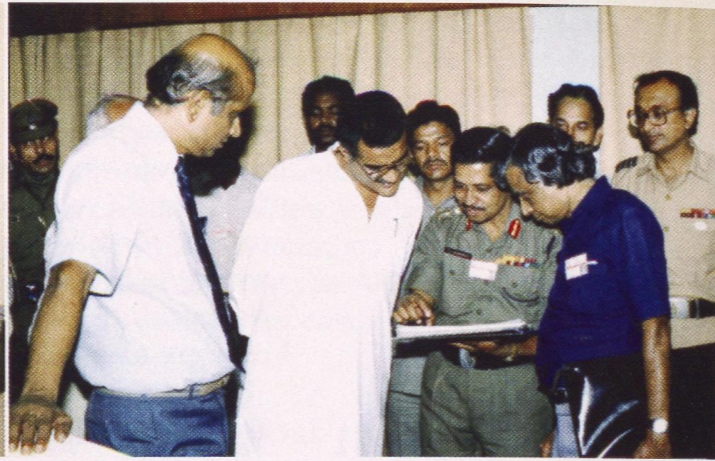
My tribute will be incomplete without covering another aspect. In Dr Arunachalam's house there would be guests almost every day for breakfast, lunch or dinner. Coming without prior intimation, most of these visitors were from the lab or lab related ones. I am one of the lucky ones who has enjoyed this gift at least one thousand times during the past 33 years! Besides, Dr Arunachalam used to participate with us in Hyderabad on Sundays in cricket matches, in chasing buffaloes wrecking the garden, and in walks up to Karmanghat or even far off Nadergul. Scientific discussions on , 'wonders', 'how', 'why' and so on were also part of these events.

The frequent occasions and variety of forms of parties and family get-togethers with Dr & Mrs Arunachalam and Dr & Mrs ML Bhatia, Dr & Mrs Dipankar Banerjee, Dr ES Bhagiratha Rao, Dr Sundararajan, Dr N Ramakrishnan, Dr Sekhar, and many scientists, were a manifestation of the unity of the DMRL family that Dr Arunachalam perceived and practiced. The wonderful, unique, whole-lab-send off given to Dr and Mrs. Arunachalam at the DMRL lawns – the only time DMRL family along with their family members gathered in one huge gathering of dance, drama, music and delight – is a true reflection of the magnitude of Dr Arunachalam's contribution to DMRL and extent of admiration that DMRL has toward him and the unity that DMRL feels with him. Dr Arunachalam seamlessly integrated the laboratory and every one of our lives and aspirations and spread unlimited enthusiasm and excitement to every area, in science, in technology, and in life, in general.

On the first day of my learning scooter driving with Dr Bhatia as the coach on my brand new Chetak, we fell badly. I was injured at many locations. Dr & Mrs Bhatia took complete, good care of me for a month or more with much affection. One day Dr Arunachalam and Meena dropped in at the Bhatias saying "we should share" and took me to their house, where I had a fabulous time in the company of his wonderful children. Only in my parents home I had stayed longer than at this home away from home.

In an exciting day following good results in armour trials, not finding his official car, Dr Arunachalam hopped behind me on my scooter. Partly due to the excitement and partly due to my lack of experience in balancing a heavier pillion rider, we fell down near Midhani gate. Dr Arunachalam would sometimes say, "You dropped me at Midhani gate, so you see, I could become its Chairman!" That is humour!





# My Reminiscences

PC Angelo  
PSG College of Technology, Coimbatore

Dr Arunachalam took over as Director of DMRL in 1975 when I was on deputation to Midhani. When I decided to quit Midhani and come back to DMRL, Dr Arunachalam asked me why I wished to come back. I informed him that I am interested to do my Ph.D. Immediately he gave his consent and also suggested a few areas in which I could do my Ph.D.

When he came to join DMRL, he was allotted a house just opposite to mine in lab quarters. During his tenure as Director, once I gave a technical talk on Auger Electron Spectroscopy. That evening, he came to our house and told my wife "you know, today Angelo gave a nice presentation. Based on his presentation, we plan to buy a Scanning Auger Microprobe". Dr Arunachalam was always generous in his appreciation.

I remember another incident very well. During his tenure as Director, DMRL he was very keen to develop a nice lawn in front of the DMRL main building. Somehow it was not very successful. During the interval between his departure to Delhi as SA to RM and his first visit to DMRL after becoming SA to RM, the lawn had taken a nice shape and was looking green and beautiful. When he entered DMRL from the airport instead of walking into the building where his successor and others were waiting, he straight went to the gardener who was tending the lawn and spent a good ten minutes with the gardener appreciating his good work. You should have seen the glint in the gardener's eyes.

It was November 16, 1982. I was told by the then Director of DMRL, Dr P Rama Rao that SA to RM wants me in Delhi on the 18<sup>th</sup> and that I may have to spend a few days there. Although I was not eligible for air travel, I was told that special permission has been given to me to travel by air. No other information was given. I reached Delhi on the 18<sup>th</sup> afternoon. At the airport, a vehicle was waiting to take me to South Block. When I reached 137, South Block, I met the staff officer to SA to RM who told me

Defence Metallurgical Research Laboratory





Taking over as SA to RM from  
Late Dr Raja Ramanna

to wait, as SA was busy. Towards the end of the evening I was told that I should meet SA the next day in his house. When I reached SA's house the next day he told me that a booklet has to be prepared for an exhibition to be held in Bombay on the 29<sup>th</sup> of November. The next three days he spent whatever time he could find apart from seeing the Asian games in his new ECIL Colour TV, in preparing a number of drafts and by 21<sup>st</sup> evening, the final draft was ready. He told me to come to his office the next day as the organisers of the exhibition are coming from Bombay to collect the draft and they will print the same at Bombay. On Monday during the meeting the organisers informed that no press in Bombay is willing to take the printing as they are all totally booked for calendar and diary printing and that the printing must be done in Delhi itself. SA just turned to me and told "Angelo you take care of this". After that he was busy for the next few days and I was busy running around to get the printing done and we did not meet each other. On the 29<sup>th</sup> morning I reached his house with 1000 copies of the booklet ready to be taken to Bombay by SA in a special flight so as to be in time for the inauguration of the exhibition. I was nervous when I took out one copy to show to SA. Dr Arunachalam saw the cover and shouted "Meena, Meena come here. See what Angelo has done". That moment still lingers in my memory. He was always generous in his praise.

As staff officer to Dr Arunachalam, I used to prepare slides for his lectures. Usually, he will suggest what he is going to talk about in a lecture and I will prepare the slides and he will see the slides atleast once before the presentation so that I can make any revisions/corrections before finalising. For one particular lecture he was to give at IIT, Delhi he could not see the slides as he was very busy. So he told me to come to IIT, Delhi half an hour early so that he could see the slides once before the lecture. As promised he came to IIT half-an-hour early. However, having been alerted from the gate about the arrival of SA to RM, Director IIT came down from his room and received SA at the portico itself and took him to his room. Director, IIT brought SA to RM directly for the lecture hall where I was standing and sweating. The whole lecture went off very well and I am sure nobody would have even suspected other than me that SA had not seen the slides even once.

Another presentation I remember very well was given in 7, Race Course, New Delhi during Sri Rajiv Gandhi's time by Dr Arunachalam, Dr Sam Pitroda & Dr Ashok Ganguly to Mr Mikhail Gorbachev. The presentation was planned for half an hour but it went on for three and a half hours. The pity was, subsequently, Mr Gorbachev lost his position and Sri Rajiv Gandhi lost his life and so nothing came out of that wonderful meeting.

I have many, many more pleasant memories of my association with Dr Arunachalam and I shall carry those memories with me forever.

# A Personal View on the Great Visionary

## Dr VS Arunachalam

M Natarajan

Scientific Advisor to Raksha Mantri

I had no idea as to who Dr VS Arunachalam was until I heard one day Dr Raja Ramanna telling Director CVRDE, in the latter's office in Avadi, about the need for a younger and a dynamic person to take over from him as SA to RM, as he would be returning back to Atomic Energy Department as its Secretary. He then mentioned that the young dynamic person was none other than Dr VS Arunachalam, the then Director DMRL. This was some time in the last quarter of 1981.

My first encounter with Dr VS Arunachalam was when he visited CVRDE, Avadi in May/June 1982, when I had the privilege of showing him around the hardware we had got ready as part of our efforts in building the transmission and drive line product of MBT - Arjun indigenously. This was followed by the visit of the Consultative Committee of Member of Parliament. There was a vociferous member, who had strong reservations about our looking for an engine for MBT from western origin, instead of Soviet Union. I remember stoutly defending the western choice purely on consideration of technology and the high power to weight ratio needed for the futuristic MBT. The member however did not seem to be satisfied with our answer, but had to digest, what we had to say in the absence of anything better. I could see the searching eyes of Dr VS Arunachalam focused on me, who, while defending our action, was already smelling trouble ahead.

The next interesting meet was when the then Director CVRDE, Brig Tandon, relinquished office in Jan 1983, he had the tough task of choosing the successor. He perhaps preferred someone younger to take over, but his advisors at that point of time propelled him to seek a compromise solution of installing the then Director Combat Vehicles at New Delhi as Director CVRDE on additional charge, much against his free will. The swipe he took, at this DCV, when the latter stated that he comes to Delhi only to have his clothes laundered, was a pointer to his impatience in having to put up with a solution not of his choice.

I saw his power of eloquence and his ability to team up potential scientists, when he made specific choice, of young scientists from various labs to meet with the then PM, Indira Gandhi. During every subsequent visit to CVRDE, the metallurgist in him was itching to solve the problems of MBT, in the form of special Armour, alloy steel, alloy track pads, sintering of clutch plates, hard chrome plating of cylinders, knuckle joints for rocking arm of suspension piston arm etc etc. He had an uncanny way of locating the trouble spots in our programmes from our presentations.

His initial dependence on R&D HQ personnel was gradually overtaken by his independent assessment and his sending the entire negotiating team for power pack out of both Delhi and Avadi to RCI in Hyderabad to finalise the contract was a master stroke in silencing critics and sending message of serious business simultaneously.



He got the MBT named Arjun, the great warrior, a name that was apparently a choice of the then Defence Minister Shri PV Narasimha Rao. He settled the issue of Directorship of CVRDE, installing Shri TK Das, undoubtedly a good and experienced Mechanical Engineer with least controversy and a gentle behaviour, with perhaps some instructions on how he envisioned.

CVRDE's leadership grooming, in the interest of this first mega project of DRDO.

When I was directly recruited as Scientist 'F' and was being handed over the appointment letter on 1<sup>st</sup> Sept 1987, I vividly recall he told me that since I had been made a Scientist 'F', he expected me to shoulder the programme's responsibility and said "Dr Krishnan the new CC R&D would brief you". I was happy to receive the appointment order, but was indeed nervous on taking on a major role and responsibility and was wanting to say something to him in response. But he was far too quick to understand my predicament and said, "I wish you the very best, I am confident of your potential and of course we are all here to help you, and so go ahead". That was enough to silence me and submit myself to his will, if I may say with some confidence. Such was his power of speaking and expression, that he quite often conveyed more than what he spoke. As I came out of the room my fear was reducing and confidence started building up. Surely he had a magic touch in infusing the confidence.

My very first visit to him, 6 weeks later, brought us in conflict, in that I insisted on the need for importing a set of steel tracks as a prerequisite for meaningful automotive evaluation. This import was objected to by Finance Ministry. But I appreciated his quick grasp of my case and he cleared the same. Later he acknowledged the sensibility of that decision, proving clearly his appreciation of good decision making.

Likewise, when I could understand clearly the missing links in our efforts to get the gun control systems designed by CVRDE at the Fire control systems designed by IRDE integrated, he very quickly grasped the importance of the same and gave CVRDE the freedom to sort it out and this eventually helped realize the integral system. There were a couple of such incidents with powerful scientific personalities of that time, whose egos at times blinded them from accepting ground realities. But Dr VS Arunachalam had a very convincing and astute way of circumventing such road blocks and ensure the programme's success.

I cannot but recount yet another interesting episode, when I showed him our ability to configure a design for automatic transmission for a passenger bus. He grasped our potential very fast and chided us by saying that instead of putting our efforts on buses we should take up the challenge in building AMAGB for LCA. As a result, the LCA is flying with the indigenously developed AMAGB today.

I can keep quoting several instances, even later when he was away from DRDO, of his sharp intellect decoding the hidden fault lines of apparent success and gently reminding the powers that be of the need for a cautious and pragmatic approach. His tenure also saw the change in the directorship of several laboratories to bring in a dynamic approach and higher standards. He brought in achievers from outside DRDO to reinforce the talents in DRDO.

He encouraged sports, adventure, academic interactions, and above all out-of-box thinking. His steel core had enough ductility to provide comfort to compassionate cases effortlessly and on time. He dealt with errands strictly and fortunately, they were far too few to impact on the organization. His gentle persuasive ways of convincing political bosses on important issues became the envy of bureaucracy both civil and military. He managed to steer clear of conflicts of interest and managed the activities of DRDO extremely well.

I must in conclusion say, that here is a personality whose span as SA to RM, gave DRDO a vision, a direction par excellence, built up essential infrastructure, ushered in the capability to system configure and design and develop major weapon systems and platforms, sent waves of excitement for innovative contributions. Yet this personality was easily approachable, down to earth, gave abundant freedom of management to each project chief, never legislated anything that would lead to regimentation. He was ever ready to help achieve the goal, unmindful of our leadership failures and error, always looked to the positive aspects of any and every task and indirectly charged every project head and lab head with his innate magnetism.

I pay my respects and regards to this great personality and bow my head in reverence to this great giver on his seventieth birthday and pray to Lord Almighty to bless him and his family with many more years of good health and cheers to be contributing to different facets of growth of our country.

# Arun at Carnegie Mellon University

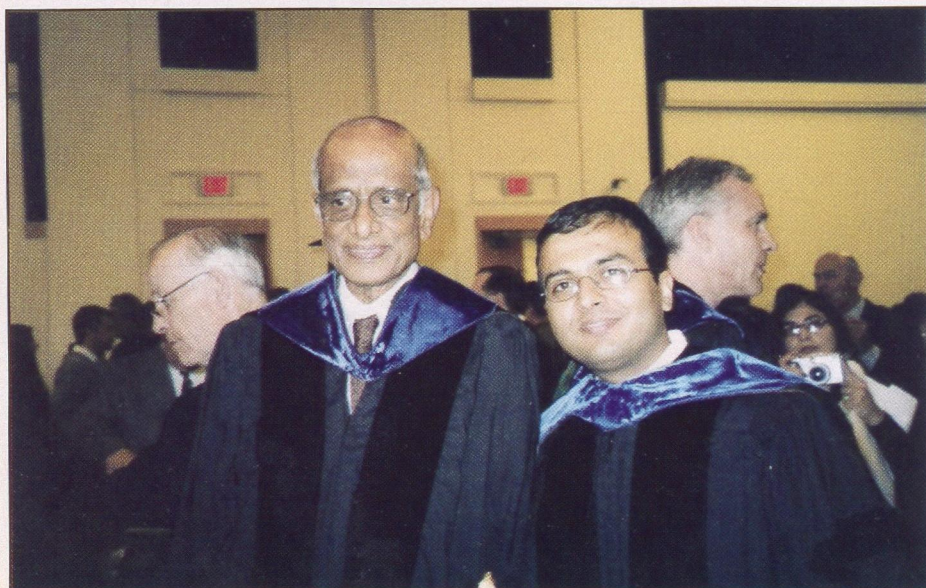
Anshu Bharadwaj

National Aerospace Laboratories, Bangalore

In 1992, Dr Arunachalam joined Carnegie Mellon University (CMU), Pittsburgh as Senior Visiting Professor in the Departments of Engineering & Public Policy and Materials Science & Engineering. Subsequently, in 1994, he was made a Distinguished Services Professor in the Departments of Engineering & Public Policy, Materials Science & Engineering and The Robotics Institute. Arun, as he is fondly called at CMU, immersed himself in inter-disciplinary research in technology, economic growth and infrastructure development in developing economies with focus on India. For several years he taught hugely popular graduate level courses dealing in technology and dynamics of economic growth in which he drew from his wealth of knowledge and experience in scientific R&D. The underlying message was that technology is an important ingredient for the growth of an economy and technology diffuses through learning, work experience and availability of the appropriate infrastructure.

Arun's biggest achievement at CMU was that he initiated several India focused projects in energy, telecommunications and IT. He attracted and motivated a large number of researchers, graduate students as

*One of Arun's great attributes is his ability to get along and easily converse with almost anyone ranging from a Gram Panchayath member to the President of The World Bank or from a graduate student to the President of Harvard University. He has a terrific presence of mind and sense of humor. A United Nations team visited CMU for discussions about the rural bio energy project in India and a Chinese member asked if a village's entire electric power requirements could be met by combustion of gobar gas from cow dung. Arun promptly replied, "For that, all the cows and buffaloes in the village will have to get diarrhea", and the audience burst into peels of laughter.*



With Anshu Bharadwaj at the Convocation ceremony, Carnegie Mellon University, May 2003.

*I first met Arun in his office at CMU during fall of 1998 when I was anxious to get admission in the PhD program at Department of Engineering and Public Policy. After all that I had heard and read about him, I walked into his room with some trepidation expecting to meet a serious looking elderly Tamil gentleman possibly with a tinge of arrogance that position and power often brings in. To my surprise I, I found a completely different personality. He was spontaneously friendly, full of humility and warmth and put me at ease with banter about almost everything under the sun from Karnataka politics to the gay rally in New York City. We chatted in Kannada and after we finished, he escorted me to the exit of the building, which left me feeling great.*

*That meeting was fateful since he agreed to have me as a student, which obviously thrilled me. The next four years were undoubtedly the best in my educational and professional life and I enjoyed the rigors of the PhD program. Arun is technically superb and keeps abreast with the latest in science and technology. His zeal and energy is infectious and while his research is focused and rigorous, he keeps the big picture in mind. He has a way with the students; he gives them a long rope and pulls it only when he feels that they are going off-track, as I was on more than one occasion. He stresses that the PhD is just a stepping stone for higher things in life and so one should get over it quickly and move on. My finest moment was when he raised a toast with champagne after my thesis defense.*

well as faculty members. Some of the key research projects were: nuclear power in India, natural gas pipeline from middle-east to India, issues in India's software and telecommunications policy and biomass energy for rural India. The funding for these projects came from a wide range of organizations such as: Rockefeller Foundation, Sloan Foundation, Alton Jones Foundation, MacArthur Foundation, US National Science Foundation, US Department of Energy, World Bank and United Nations. Some of these projects involved leading Indian institutions such as IIT Mumbai, NAL Bangalore, IGCAR Kalpakkam, IISc Bangalore and TERI, New Delhi. The research findings were published in several leading journals and were widely acclaimed. In 2002-03, he organized two workshops in "Information and Communications Technologies for Sustainable Development"; first in The World Bank, Washington DC and the second in Bangalore. These were attended by a galaxy of distinguished scientists, economists and policy makers and the findings were published as a book: ICT for Sustainable Development, co-authored with Dr Rahul Tongia.

Arun relocated back to Bangalore in 2002 with his appetite for research and capacity for hard work undiminished. He recently established a Center for the Study of Science, Technology and Policy (CSTEP), a non-profit thinktank whose objective is rigorous analysis of interdisciplinary problems in technology, economics and policy.

The vision of CSTEP is to develop and present non-partisan policy options for harnessing technologies and provide viable strategies for India's human development and prosperity. The initial plans are assessment of technological options in areas such as energy, information and communication technologies and materials for both public and private sectors and to develop appropriate tools for rigorous policy analysis.

He works long hours, writes and travels extensively; and in fact it's difficult to catch him in Bangalore. When I do catch him, I enjoy his and Mrs Arunachalam's company with excellent food and choicest selection of wines. Sometimes when I go on the internet late in the night, I can see him online, most probably on a Skype conference with his colleagues in the US who are 9-12 hours behind in time zone. Knowing Arun, there is absolutely no doubt that he will achieve spectacular success in his new endeavor and CSTEP will become a top quality organization.

# “Beyond Technology” – Dr VS Arunachalam: Scientist, Scholar, Economist, Philosopher, Mentor, and Humanist

Rahul Tongia

Carnegie Mellon University, Pittsburgh PA, USA

If one examines some of the publications and courses taught at Carnegie Mellon University over the last dozen years or so by Dr Arunachalam, they mostly do not deal with Metallurgy, Materials, or even traditional Engineering. Topics have included Economics of Technological Change, Innovation, Optical Networking, Knowledge Networks, and the Information Society. His work has spanned the energy, telecom, innovation, and education domains, especially focusing on India. In fact, despite being at Carnegie Mellon in Pittsburgh, USA, he led numerous studies, projects, and programs focusing exclusively on Indian technology and policy (and I was fortunate to be a collaborator in many of these efforts). Now, he has returned to Bangalore and established a new non-profit Think Tank: Center for Study of Science, Technology, and Policy (CSTEP).

If one laments a digital divide in terms of access to connectivity, there is often a greater divide between

technologists and policy-makers. Technology rarely occurs in a vacuum or “black box.” Non-technical issues often dominate, especially when we consider technologies related to society, such as infrastructure. Dr Arunachalam was always a pioneer in the use of technology (being amongst the first at the highest levels of Government to personally use and integrate computers), and he was also innovative in analyzing technology. Going beyond technology, through a command of economics, policy, regulation, etc., since retiring from Government service he has pioneered studies on natural gas pipelines for India, role of nuclear power, biomass energy,



Smt and Dr Arunachalam with PhD students and their families at Carnegie Mellon University, October 2002.

optical networking, and the role of IT for human development. While being interdisciplinary, his work has been and remains scholarly rigorous.

In addition to the quality of the analyses he has led, one hallmark of his work has been intellectual honesty. While he was in the government for many years, and his position always required finesse and diplomacy, his scholarly work paid no homage to any sacred cows. His impartiality, rigour, and openness to new ideas and surprising results sometimes bred disdain, enmity, or even false accusations questioning his patriotism! His work and ideas speak for themselves, and his predictions and visions have borne fruit.

To paraphrase Dr Arunachalam's views based on his conversation with a distinguished colleague, where I happened to be present, India's strength comes not from its military might per se, but from its growing economy and its dynamic population. Dr Arunachalam always believed in the power of knowledge and the human spirit – if given the right opportunities. His optimism shone through in his writings, and he especially saw women's education as a path towards development.

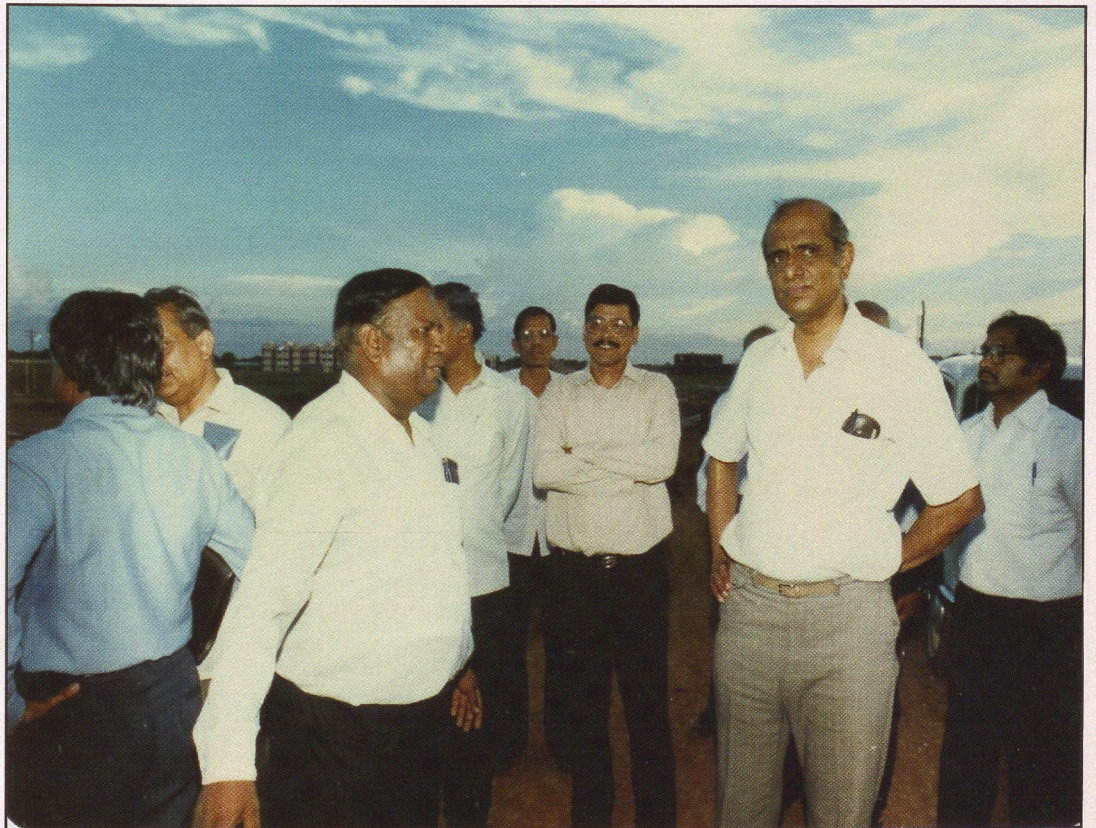
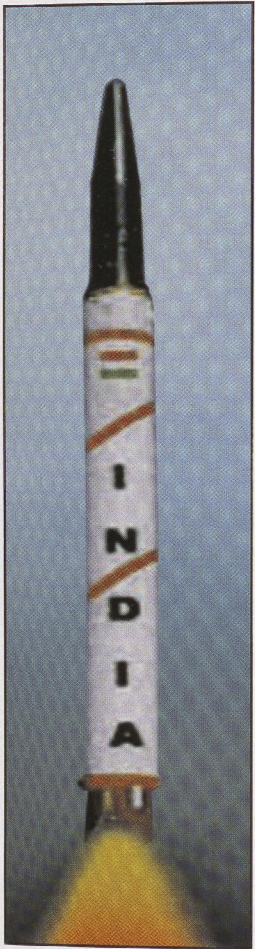
Information Technology and Software are now associated with India, and Dr Arunachalam has played a small but valuable role in this, especially in terms of what the government thinks of this industry, and the support and freedom given to many of the pioneers of the field. India is moving towards broadband connectivity for its people, and a seminal step was the introduction of optical fibers throughout the country. The Dept. of Telecommunications was hesitating but Dr Arunachalam, as Chair of the Committee on such matters, pushed through the deployment, and today we have this infrastructure to thank for much of our communications. Incidentally, as a young scientist working on Fourier Transforms, he developed algorithms and some software to do the calculations using nascent computing technology. This became perhaps India's first software export many decades back when he shared it with some scientists in the US, and some weeks later was surprised when they had sent a cheque for it! His collaborative study on the Indian Software Industry from a few years back became one of the most cited works from the US National Bureau of Economic Research (NBER). Today, he is on the Board or Advisory Board of leading IT companies amongst others.

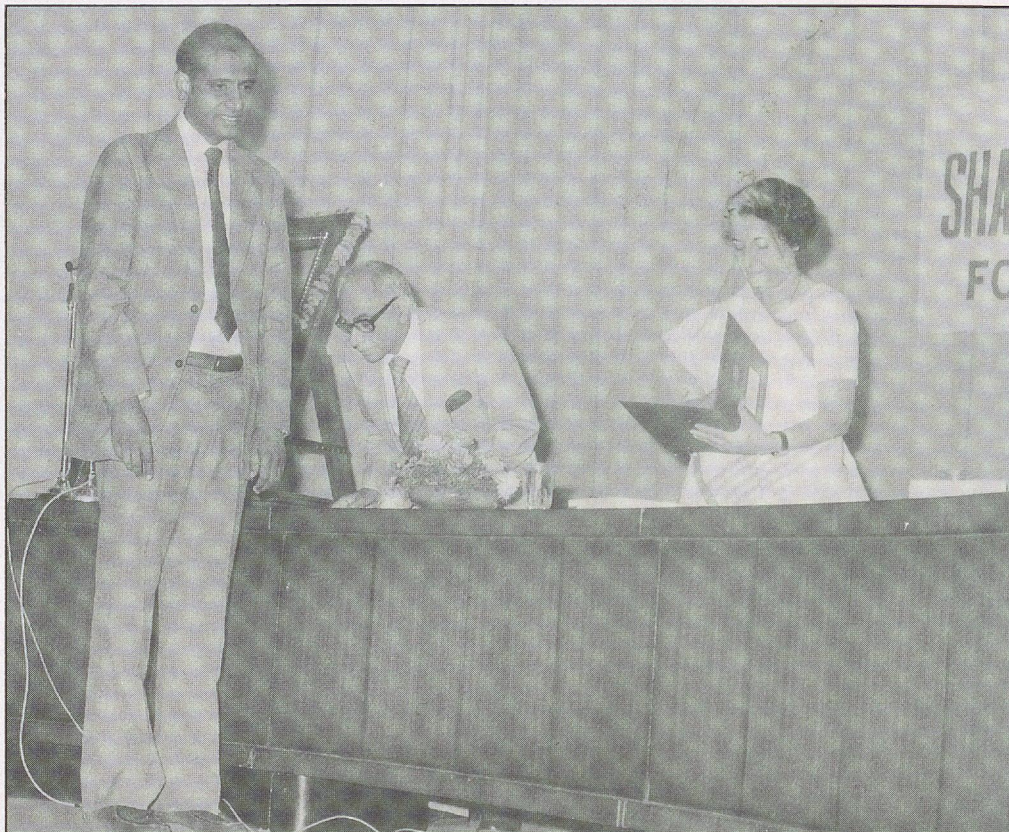
*To truly understand Dr Arunachalam, one has to look beyond his achievements. Why does he work 15 hour days during what many would have considered a "retirement period?" As Andrew Carnegie stated, "My heart is in the work." One of Dr Arunachalam's secrets has been to pursue diverse and challenging fields of learning, study, and inquiry. He has been a prolific and stylistic writer, having been invited by many publications and bodies such as Foreign Policy, The Economist, the United Nations, etc. to write, present, and comment. In fact, he has mentioned wistfully that while he might enjoy science, as an author he would consider that he had "really arrived" if the New Yorker magazine would invite him to write. Nonetheless, he has written non-technical materials far and wide, ranging from briefing notes seen by Ministers and Heads of Government to columns in newspapers.*

In addition to his work output, his personal style has been a factor in inspiring not one but two generations of scientists, scholars, and leaders. Even when perhaps the senior-most Secretary in the Government of India (over a decade as Secretary), he had a simplicity and austerity that is still spoken of today. He refused many of the privileges available to him (reminding people he was a scientist, not a bureaucrat), and declined Z-level or even special security protection. First hand, I have repeatedly seen his simplicity and humility, his going out of his way to learn from and to help others. One anecdote from 1997 stands out in my mind. I was then a graduate student doing my Ph.D. under him, and he had been invited to give the Keynote Address at India's 50<sup>th</sup> Independence Day celebrations in New York. I had arranged to buy a used car in New York, and intended to drive the 600 km back to Pittsburgh (after taking the bus to New York). When I mentioned that I would be able to join him in New York for the celebrations because of my plans, he asked if I had ever driven from New York to Pittsburgh before, as the roads could be a little tricky. When I said no, without hesitation, he offered to help drive back with me! This is despite the first class plane tickets the Celebrations' organizers in New York must have already bought him. Dr Arunachalam's warmth extended to the welcome I, and all his students, were given at his home, where we would often be invited for some excellent *dosa* or *bisse bille bhaath* from Meena, his wife, along with scintillating conversation. Even when she was not around, he would do the cooking himself. His culinary creations, he observed, were different from Meena's, as they were optimized to be had with a nice drink.

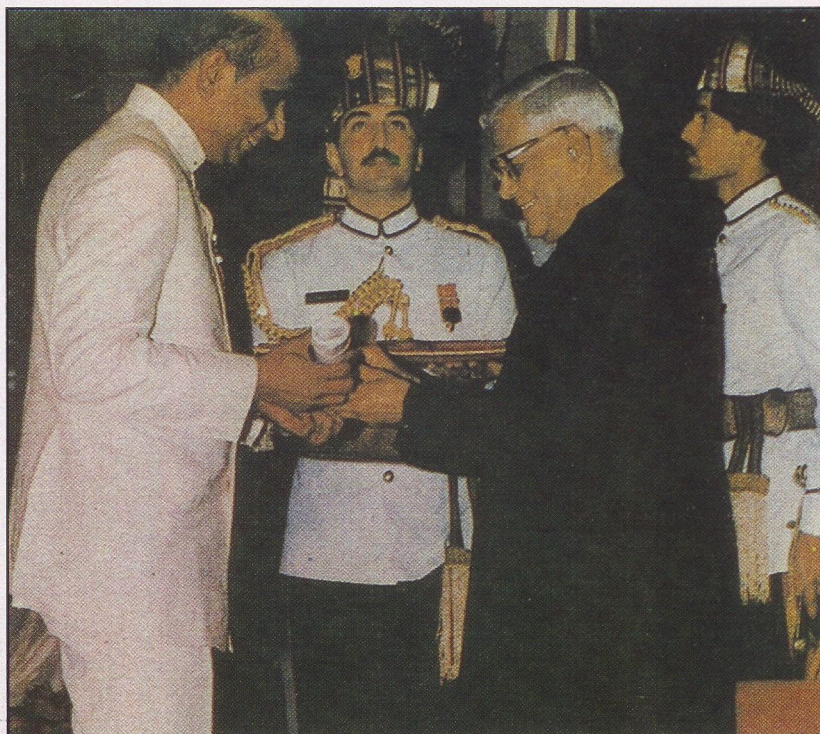
I regret I am not able to join everyone in personally celebrating Dr Arunachalam's 70<sup>th</sup> Birthday, but I will be there in spirit. I look forward to many years of further learning from and working with him on various issues of technology, policy, and society in India.







Nation salutes Arunachalam, the scientist,  
Receiving Shanti Swarup Bahtnagar Prize from Smt Indira Gandhi, the then Prime Minister



Receiving Padma Vibhushan from  
His Excellency Shri R Venkataraman, the then President of India

National Metallurgists Day Award	1974
Kamani Gold Medal of IIM	1975
VASVIK Award for Materials Science & Technology	1980
Shanti Swaroop Bhatnagar Prize	1980
FICCI Award for Technology	1984
Padma Bhushan	1986
National Design Award	1986
Tata Gold Medal of IIM	1988
Bhasin Cash Award for S&T	1989
Jawaharlal Nehru Memorial Prize for S&T by Govt. of Madhya Pradesh	1989
Padma Vibhushan	1989
Platinum Medal of IIM	1989
Engineering Lecture Award, University of Wales	1996
First recipient of D.S. Kothari Gold Medal, Indian Science Congress	1998

<b>1996</b>	<b>Member Materials Research Society, and Member of the Editorial Board of MRS Bulletin</b>
<b>1991</b>	<b>FREng. Foreign Member and Fellow of Royal Academy of Engineering UK</b>
<b>1991</b>	<b>FIETE Honorary Fellow Institution of Electronics and Telecommunication Engineers</b>
<b>1988</b>	<b>FNASc Fellow of National Academy of Sciences</b>
<b>1987</b>	<b>FNAE. President (1991-1992) and Fellow of Indian National Academy of Engineering</b>
<b>1984</b>	<b>FNA Fellow of The Indian National Science Academy</b>
<b>1982</b>	<b>FAeSI President (1986-1988) and Fellow Aeronautical Society of India</b>
<b>1979</b>	<b>FASc Fellow of Indian Academy of Sciences</b>
<b>1966</b>	<b>Honorary Member and Past President (1987) of the Indian Institute of Metals</b>

