Indian Institute of Science
IISc GLOBAL CONFERENCE

The Next 100 Years

June 22-24, 2007

Santa Clara Marriott, California, USA

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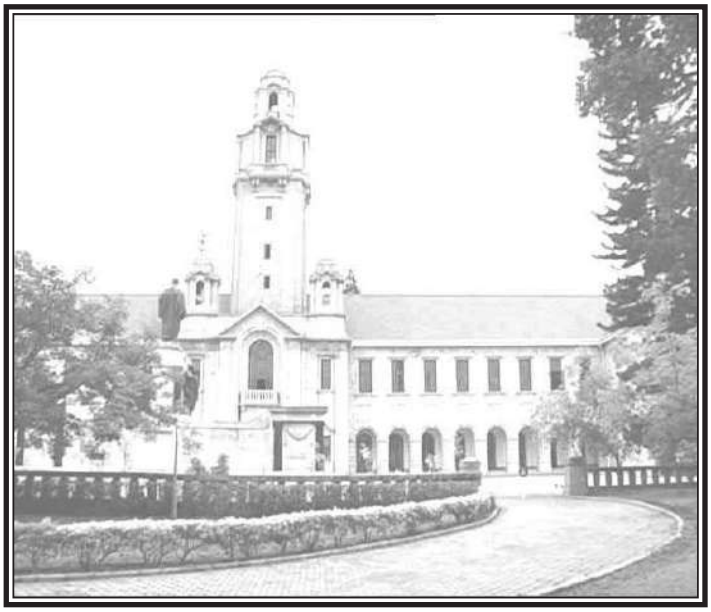
Indian Institute of Science
GLOBAL CONFERENCE

Celebrating Leadership in Science, Technology and Innovation

The Next 100 Years

June 22-24, 2007
Santa Clara Marriott, CA, USA



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Indian Institute of Science Global Conference 2007

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IISc in Pictures

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Editor's Note:
In order to preserve the vibrant diversity of the English dialects used in various parts of the world, we have refrained from standardizing the usage and spelling of words across this publication. Opinions expressed in the souvenir are those of individual authors and not of IISc or IISc AANA. Logos and artwork are the sole responsibility of individual sponsors/advertisers.

Indian Institute of Science
Alumni Association of North America
(A Non-Profit California Corporation)

Welcome from the Conference Chairs and Convener

On behalf of the Indian Institute of Science (IISc) and the IISc Alumni Association of North America and Silicon Valley groups, it is our distinct pleasure to welcome you to the Indian Institute of Science Global Conference, Silicon Valley, 2007.

This is the first IISc Global Conference, bringing together the Institute's faculty, its management, its alumni, industry and other academic institutions, particularly the University of California (UC) system, in a highly congenial environment to explore and build collaborative partnerships. The conference also marks the beginning of celebrations commemorating the first 100 years of the Institute.

Sir Jamsetji Nusserwanji Tata founded the Institute in 1909 with a vision to build a premier institution for advanced studies in science and technology. Within a few years of its founding, the Institute became one of the elite institutions of research and higher learning, not only in India but around the world. Today, the Institute is at the forefront of scientific and technological breakthroughs in all areas of research including, but not limited to, fundamental sciences, aerospace and automotive, electronics and electrical sciences, power and energy, nanotechnology, bio-sciences and material sciences. The IISc is the only institution in India to have had a Nobel Laureate (Sir C. V. Raman) as a Director and faculty member and today, it is India's only institution to be counted among the world's top 20 institutions.

We have structured this conference keeping in mind the Institute's heritage of greatness. The main focus of the conference is on Celebrating the Institute's Leadership in Science and Technology, although on Friday, June 22, it provides an ideal venue for IISc Alumni get-togethers in a social and semi-formal environment to rejuvenate personal and professional relationships. On Saturday, June 23, the conference offers over nine hours of thought-provoking sessions on (1) Innovation and Entrepreneurship (2) Life Sciences - Science and Society (3) Management of Technology and (4) Education for Innovation and Sustainable Development. On Sunday, June 24, discussions turn to collaborative interactions in six highly engaging parallel sessions of three hours each on (1) Knowledge Sciences and Services (2) Information, Communication, Computers and Technology (3) Bio-Technology and Health Care (4) Alternate Energy and Environment (5) Aerospace and Automotive and (6) Nanotechnology, Semiconductors and Materials. These intellectually stimulating sessions are interspersed with high quality entertainment and cultural events on Friday and Saturday evenings.

IISc's senior-most executives have been enthusiastically supportive of this conference and have co-led and played an active role in all phases of its planning and will participate in it, along with an additional 40 or more renowned faculty members, who are traveling from Bangalore, India. This will present a one-of-a-kind opportunity for collaboration and interaction to all participants in the conference. Outside the IISc premises, this is perhaps the only place where conference attendees can freely interact at the same time with so many of India's leading researchers and engage in stimulating discussions. The North America and Silicon Valley Alumni groups are extremely humbled by this level of cooperation from the Institute and we are truly grateful.

.../contd.

Over 15 corporations that are leaders in applying scientific and technological innovations in their product and service offerings and associated research and development are sponsoring the conference. Senior executives of these and many more corporations will be participating in various sessions of the conference. In addition, policy makers and researchers from many North American universities are taking part in the conference. We deeply appreciate their participation.

The Silicon Valley (with UC and Stanford) is the hub of technological innovation in the western world and Bangalore (with the IISc) is the natural counterpart in India and this conference will provide a forum for formulating and enhancing strategies to bridge the two areas and institutions. In addition to IISc-Alumni-Academics-Industry collaborative deliberations, one of the main objectives of the conference will be to provide guidance on Shaping the Future of IISc. The Institute's management and faculty members are actively soliciting ideas to develop the "IISc Vision for the Next 100 Years" and there will be multiple opportunities to brainstorm on this topic.

The Conference is the result of tireless effort by many dedicated volunteers in the Silicon Valley, North America and India, exemplifying the strength of collaboration among teams in different continents, and extending beyond the Institute to the Pan-IIT and TIE. It has been a great learning experience and a delightful pleasure working with all the teams.

All of us in the Conference Organizing Committee and Conference Steering Committee are thankful for your participation in the conference. We have worked very hard to construct a conference program that strikes an optimum balance between professional, intellectual, academic and social aspects and we sincerely hope we have been successful in this endeavor. We will truly appreciate your constructive feedback to help us achieve continual improvement.

Once again, welcome to the first Indian Institute of Science Global Conference, Silicon Valley, 2007: The Next 100 Years!!!

Dr. Ram Akella	Dr. Sangeneni Mohan	Dr. Parveen Jain
Conference Chairman	*Conference Co-Chairman*	*Conference Convener*

राष्ट्रपति
भारत गणतंत्र
PRESIDENT
REPUBLIC OF INDIA

MESSAGE

I am extremely happy that the Indian Institute of Science will be celebrating its centenary soon. Over the last hundred years this Institute has stood for excellence for scientific research and education. The growth of the institute is directly linked to the growth of science and technology in the country, particularly during the last six decades after independence. The institute has been a fountain of knowledge for all the national initiatives and development. Today you can find alumni of IISc working in every reputed institution in India and abroad both in the public and private sector providing leadership.

I am indeed delighted that the first IISc Global Conference is being held in Santa Clara, California, signifying the borderless nature of science and technology. This meet I am sure will definitely bring the scientific community much closer and provide the needed knowledge and experience for enabling faster growth of vibrant India and forge stronger collaboration between the Institute, its alumni and world leaders in research and education. I visualize that IISc will become world leader in research and development and the origin for many innovations within a decade.

I wish the Conference all the success.

07 June 2007

(A.P.J.Abdul Kalam)

Indian Institute of Science Heritage

J N Tata
Founder

Krishnaraja Wodeyar
Maharaja of Mysore , Patron

Morris W Travers
Director, 1909-1914

A G Bourne
Director, 1915-1921

M O Forster
Director, 1922-1933

H J Bhabha
Honorary Fellow, 1932

C V Raman
Director, 1933-1937

J C Ghosh
Director, 1939-1948

M S Thacker
Director, 1949-1955

S Bhagvantam
Director, 1957-1962

Jawaharlal Nehru
Honorary Fellow, 1959

M Vishvesvaraya
Honorary Fellow, 1959

S Dhawan
Director, 1962-1981

Vikram Sarabhai
Honorary Fellow, 1968

J R D Tata
Honorary Fellow, 1968

D K Banerjee
Director, 1971-1972

S Ramaseshan
Director, 1981-1984

C N R Rao
Director, 1984-1994

G Padmanaban
Director, 1994-1998

G Mehta
Director, 1998-2005

P. Balaram
Director, 2006-Present

INDIAN INSTITUTE OF SCIENCE
BANGALORE - 560 012 (INDIA)

MESSAGE

The Indian Institute of Science, Bangalore, will mark its centenary year beginning on May 27, 2008. A passage of 100 years since the founding of the Institute provides an unique opportunity to reflect on the past and to plan for the future. IISc's growth over a century is intimately intertwined with the development of science and technology in India. The Institute has contributed in a major way to the building and growth of many public institutions and has been a participant in the spectacular advancement of private industry over the past several years. The alumni of the Institute have contributed in a major way to many of the developments which will undoubtedly ensure a bright future for India.

The first IISc Global Conference being held in Santa Clara, California, USA, is an event that signifies a new level of engagement between the Institute and its many alumni who are scattered across the globe. We hope that this conference will only be the first in a series of events which will help in building a Vision for the future of the Institute. The dramatic changes that have taken place in the world's economy will undoubtedly find a reflection in the sphere of higher education and research. The Institute must be concerned with enhancing its academic profile in an increasingly competitive global environment. The active participation of its alumni will be necessary in forging new research collaborations, both individual and institutional. We hope to welcome all participants to Bangalore in December 2008 – January 2009 for a major conference to mark a century of science at IISc.

P. Balaram
P BALARAM
Director

N Balakrishnan
N BALAKRISHNAN
Associate Director

Friday, June 22 - Strengthening Alumni Relationships: Open Dialog with Alumni to Shape IISc's Vision for the Next 100 Years				
Event		**Time**	**Speakers / Panelists**	**Venue**
Registration		Noon to 9 PM		
Lunch		Noon to 2 PM		California Ballroom Salons 6 to 9
Divisional Get Togethers and Batch Reunions	**Biological Sciences**	2 to 5 PM	Prof. P. Balaram & Division Alumni	California Ballroom Salon 4
	Chemical Sciences		Prof. Chandrasekaran & Division Alumni	California Ballroom Salon 1, 2, and 3
	Electrical Sciences		Prof. Balakrishnan & Division Alumni	Grand Ballroom Salons A & B
	Mechanical Sciences		Prof. Chattopadhyay & Division Alumni	Grand Ballroom Salons C, D & E
	Physical and Mathematical Sciences		Prof. S. Mohan & Division Alumni	California Ballroom Salon 5
Dinner		6 to 8:00 PM	Professor P. Balaram, Director, IISc and Distinguished Alumni of IISc	California Ballroom Salons 6 to 9
Jugal Bandhi: Violin (Carnatic) and Sitar (Hindustani)		8:00 PM	Arvind Lakshmikanthan and Prasad Jogelkar	
Saturday, June 23 - Building a Platform for Global Innovation & Collaboration				
Event		**Time**	**Speakers / Panelists**	**Venue**
Registration		7:00		
Breakfast		7:00	All	California Ballroom Salon 6 to 9
Welcome Speech		8:00 to 8:15 AM	Profs. Ram Akella & S. Mohan	California Ballroom Salons 1 to 5
Director's Address		8:15 to 8:35 AM	Prof. P. Balaram, Director, IISc	
Inaugural Address (video feed)		8:35 to 9.15 AM	His Excellency A. J. Kalam President of India	
Plenary Speech Public Universities and Public-Private Partnerships		9:15 to 9.45 AM	Chancellor Robert J. Birgeneau University of California, Berkeley	
Session 1: Innovation and Entrepreneurship	**Keynote:** Developing Technical Leaders to their world-class potential	9:45 to 10:15 AM	Mr. Jim Morgan Chairman Board of Directors, Applied Materials	
	BREAK	10:15 to 10:45		
	Panel Discussion Key Challenges and Success Factors in fostering Innovation and Entrepreneurship Leadership in Start-ups as well as in Large organizations	10:45 to 11:30 AM	**Moderator:** Vish Mishra, VC, Clearstone Ventures **Panelists:** Navin Chadda, MD, Mayfield Dr. Vijay Chandru, CEO, Strand Life Sci. Sanjay Subhedar, Founder, Storm Ventures Sriram Viswanathan, VP, Intel Capital, Dr. Parveen Gupta, SVP, Satyam Computers.	

Program (contd.)

BREAK		11:30 to 11:45 AM		
Session 2: Management of Technology	**Keynote:** Global Technology Collaboration: Connecting and Protecting the World's Future	11:45 to 12:15	Dr. Robert Krieger, CTO, Boeing	California Ballroom Salons 1 to 5
	Panel Discussion Explore the challenges and success factors in managing technology from incubation to productization in small and large companies and in offshore service providers who are increasingly becoming outsourced R&D centers	12:15 to 1:15	**Moderator**: Dr. Janaki Akella, Partner, McKinsey & Co **Panelists:** Lakshmi Narayanan, Vice-Chairman, Cognizant, Raj Shah, Google, Ted Goldstein, VP, Theranos Arjun Malhotra, CEO, Headstrong Dr. Mark Pinto, CTO, Applied Materials	
LUNCH		1:15 to 2:00		California Ballroom Salon 6 to 9
Session 3: Life Sciences	**Keynote** Energy Needs of Developing Economies	2:00 to 2:30	Dr. Arno Penzias, Nobel Prize in Physics, 1978	California Ballroom Salons 1 to 5
	Panel Discussion Global Status of Life Science Applications and Businesses, The Context for the Emerging BT industry in India	2:30 to 3:45 PM	**Moderator:** Dr. G Kishore, MD, Burrill & Co **Panelists:** Dr. David Fischhoff, VP Tech & Strategy Development, Monsanto Dr. Rathin C. Das, CEO, Affitech Dr. Venkata Palle, Advinus Therapeutics	
BREAK		3:45 to 4:15 PM		
Session 4: Education for Innovation and Sustainable Development	**Keynote:** Education for Innovation Leadership	4:15 to 4.45 PM	Dr. R. Chidambaram Principal Scientific Advisor, Government of India	
	Panel Discussion Explore how Universities can shape their research, student professional development, and collaborations to more effectively promote innovation and sustainable economic development in our Societies	4:45 to 5:45 PM	**Moderator**: Prof. Gretchen Kalonji (UC Office of the President) **Panelists:** Prof. P. Balaram, Director, IISc Dr. Mark Kamlet, Provost, Carnegie Mellon University Prof. Shankar Sastry, UC Berkeley Dr. Sudhakar Varnasi	
Free Time		5:45 to 6.30 PM		
DINNER		6:30 to 8 PM	All	California Ballroom Salons 6 to 9
IISc Ballet		8:00 PM	Jyothi Lakkaraju, Anuradha Nag, Vidya Subramaniam	California Ballroom Salons 1 to 5

Program (contd.)

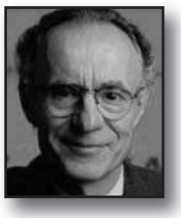
Sunday, June 24 - Collaboration and Recreation				
Event		**Time**	**Speakers / Panelists**	**Venue**
Tea / Coffee		8:00 to 8:30		California Ballroom 6 to 9
Opening address		8:40 - 9:00	Professor N. Balakrishnan Associate Director, IISc	Grand Ballrooms A to E
Workshop 1: Knowledge Sciences	Keynotes, Panel & Collaboration Workshop: Effective new ways to create, store, and retrieve knowledge to solve needs of firms in executive decision making and operational efficiency	9 to Noon **Brunch:** 10:30 to 11 AM	**Keynote Speakers:** Chair: Prof. N. Balkrishnan, IISc Prof. Jitendra Malik UCB Mr. Lakshmi Narayana Cognizant, Dr. Anant Jhingran IBM **Search/Business/Data Analytics and Knowledge Services** Dr. Umesh Dayal HP Prof. Veni Madhavan IISc Prof. Ram Akella UCSC/SVC Dr. Jim Sphorer IBM, Dr. M.P.Ravindra, Infosys Dr. Adam Baguelin AOL, Dr. Neel Sundaresan eBay, Dr. Ashok Chandra, Microsoft, Dr. Charles Lickel IBM Dr. C. Mohan IBM, Dr. P. Anandan Microsoft, Dr. Ravi Kumar, Dr. Satya Keerthi, Yahoo Dr. Sameer Pathak Oracle, Dr. Paul Hofman SAP Dr. Arindham Sinha Sathyam Dr. Jim McDonnell Cisco, Dr. Amar Rayes Dr. David DeMello Global Collaboration Panelists Prof. Balakrishnan IISc Prof. Shankar Sastry, UCB Dr. Ken Schmidt,Yahoo Research	Grand Ballroom A
Workshop 2: Information, Communication, Computers & Technology	Keynotes, Panel & Collaboration Workshop: Advancing Research and Education	9 to Noon **Brunch:** 10:30 to 11 AM	**Keynote Speakers:** Chair: Prof Raghu Raghavendra, USC Prof. S. S. Iyengar, LSU Prof. Jun Li, Vice Dean, Tsinghua Univ, China Prof. Thomas Kailath, Stanford Prof. Praveen Varaiya, UC Berkeley **Advancing Research and Education:** Chair: Prof. Viktor Prasanna, USC Dr. Kirstie Bellman, The Aerospace Corporation Prof. Garcia-Luna (UC, Santa Cruz) Dr. M.P. Ravindra, Infosys **Global Collaboration Panelists**: Moderator: Dr. Sri Kumar, BAE Systems Professors Gopinath, IISc Prof. Sargur Srihari, SUNY, Buffalo Dr. Ken Schmidt,Yahoo Research Prof. Sham Navathe, Georgia Tech Drs.Don Winter and K. Shankaran, Boeing Phantom Works Jeetan Singh, HighPoints Learning, Giri Mamidipudi	Grand Ballroom B

Program (contd.)

Workshop 3: Bio-Technology & Health Care	Keynotes, Panel & Collaboration Workshop: Case Studies on IISc's collaboration with Indian and global Life Science industries and discussion on Collaboration and Leadership opportunities	9 to Noon **Brunch:** 10:30 to 11 AM	**Role of IISc in supporting Life Science industry in India: Chair** Paturu Kondaiah **IISc's collaboration with Indian and Global Life Sciences industries**: Prof. V Nagaraja, Prof. Rajan Dighe, Dr. Vijaya Chandru, Prof. S. Chandrasekaran, **Contribution of IISc Alumni to Life Sciences industries, Case Studies:** Dr. Subba Rao Gunupudi, Prof. Channa Reddy, Dr. Sekhar Boddupalli **Plenary Discussion**: Moderator P. Balaram, Distinguished Faculty & Experts	Grand Ballroom C
Workshop 4: Alternate Energy & Environment	Keynotes, Panel & Collaboration Workshop: Challenges in meeting energy needs of our planet and balancing them with environment impact	9 to Noon **Brunch:** 10:30 to 11 AM	Drs. Ashok Sinha, Arkal Shenoy, Surinder Bedi, Sukumar, Raghavendra Gadakar, Ravindranath, J Nagaraju, Krupanidhi, Subhash Singhal, V. Ramanathan, Murthy Gudipati	Grand Ballroom D
Workshop 5: Aeronautics and Automotive	Keynotes, Panel & Collaboration Workshop: Advances in Aeronautical and Automotive research	9 to Noon **Brunch:** 10:30 to 11 AM	Drs. Roddam Narasimha, Dattaguru, Ravi Rout, Anil Sachdev, Kota Harinarayana, Upadhya, Raghunandan, Chattopadhyay, Gurumurthy, Gopalkrishna, Ramesh Rao, Mohan Trivedi, K.K. Sankaran (Boeing), Bala Bharadwaj (Boeing)	Grand Ballroom E
Workshop 6: Nanotechnology & Materials	Keynotes, Panel & Collaboration Workshop: Advances in materials, technologies and key challenges in the Nano world	9 to Noon **Brunch:** 10:30 to 11 AM	Drs. S Mohan, S Ranganathan, Krishna Saraswat, Bhakatha Rath, Navkant Bhat, Rudrapratap, Reghu Menon, Arindam Ghosh, Umarji, Ashok Raichur, R Chidambaram, VK Aatre, P Ramachandra Rao, Vivek Subramanyam, Ajay Malshe, Muralidhar Ghantasala, Shekhar Bansali, Srikar +3, Chris Pringle, Mark Pinto, Om Nalamasu, Keshav Prasad, Pravin Narwankar, Kaushal Singh, Subhash Mahajan	Seattle and Portland
Conference Close		Noon to 12.15 PM	**Convener:** Dr. Parveen Jain	Grand Ballroom A to E
RECREATIONAL ACTIVITY: Santa Cruz or San Francisco 1PM to 7 PM Meet at Marriott Lobby				

Speakers

Arjun Malhotra serves as the Chief Executive Officer and Chairman of Headstrong's Board of Directors. Prior to Headstrong, he was CEO and Chairman of TechSpan, which merged with Headstrong in October 2003. He is a winner of the Silicon Valley Entrepreneurs Award, and has had several entrepreneurial successes. He co-founded the HCL group in 1975, taking it from a six-person "garage operation" to one of India's largest Information Technology companies.



Dr. Arno Penzias, winner of the Nobel Prize in 1978 and many other awards, is known for his contributions to radio astronomy, impact of science on society and for his fundamental restructuring of Bell Labs, which created a novel paradigm of university-industry partnership that has proved to be an effective model for many other organizations. Dr. Penzias currently serves on several important bodies of research including the Board of Directors of Konarka Technologies, Council on Competitiveness and as Vice Chairman, Committee of Concerned Scientists.

Dr. Ashok Sinha earned his B. E. in Metallurgy from IISc and a D. Phil from Oxford University. He has contributed to solid-state physics at Cal Tech, to semiconductor process technologies at Bell Labs, and to semiconductor process equipment business at Applied Materials, from where he retired as a Senior Vice President in 2006. A Fellow of the IEEE, he received the Institute's Alumni medal in 1965 and the Distinguished Alumni award for 2005. He has served on the Boards of several companies, including The Tech Museum of Innovation in San Jose, CA.

Professor Balaram is a professor of Molecular Biophysics and the Director of the IISc. He received his Ph D in Chemistry from Carnegie Mellon University in 1972. He is a celebrated researcher in the areas of bioorganic chemistry and molecular biophysics. He is a Fellow of The Academy of Sciences for the Developing World (TWAS) and is the recipient of numerous awards and honors including the Shanti Swarup Bhatnagar Prize of CSIR (1986), TWAS Award in Chemistry (1994), G.D. Birla Award for Scientific Research (1994), Distinguished Alumnus Award of IIT Kanpur (2000) and Padma Shri (2002). He is a key member of many committees of the Government of India, and is currently a Member, Science Advisory Committee to the Union Cabinet and the Scientific Advisory Council to the Prime Minister. He has been the Editor of Current Science for over a decade.

Prof. Balakrishnan received his Ph.D. from IISc in 1979, and is the Associate Director of the Institute. A celebrated researcher in the areas of Numerical Electro-magnetics, High Performance Computing and Networks, Polarimetric Radars and Aerospace Electronic Systems, Information Security and Digital Library, he has received many awards including the Padma Shri (2002), Alumni Award for Excellence in Research for Engineering and Science of IISc (2001), Bhabha Award of Excellence in Applied Sciences by UGC (2004) and the National J C Bose Fellow-ship, 2007. He is a Fellow of The Academy of Sciences for the Developing World (TWAS) and a member of leading Regulatory and Advisory Committees. As a key advisor to the Government of India on Science and Technology, he has been the main architect of many critical S & T National initiatives in IT, Information Security, and Defense.

Prof. Chandrasekaran is the Chairman of the Chemical Sciences Division at IISc. He received his Ph.D. from Madras University and conducted his Post-Doctoral research at Harvard University and Syntex, Palo Alto, USA. He has received several prestigious awards including the S.S. Bhatnagar Prize. He developed innovative methods to synthesize natural products in the lab. His technology helped in the identification of several novel candidate molecules for therapeutic uses.

Speakers

Prof. Chattopadhyay is the TataChem Professor and the Chairman of the Department of Metallurgy at the Indian Institute of Science. He leads the Non Equilibrium Processing and Nano Materials Lab that focuses on Rapid Solidification and Processing, Welding and Cladding, Mechanical Alloying and Laser Ablation. Prof. Chattopadhyay is also an Associate Faculty in the Materials Research Center.

Prof. Dattaguru received B.E., M.E. and Ph.D. (Engineering) from the Indian Institute of Science. He was the Chairman of the Department of Aerospace Engineering (1999-2003), Chairman of Centre for Scientific & Industrial Consultancy (1996-2000) and Convener for the Joint Advanced Technology Programme at IISc. He held the KSIIDC Chair for 3 years and received the Rustom Choksi award for excellence in Engineering Research from IISc, the Academic Excellence award from Defence Research and Development Organisation, 2002 and Padma Shri in 2005 for Science & Technology. He is currently a Consultant to Satyam Computers, Cades Digitech, and CSM Software at Bangalore.

Dr. David Fischhoff is Vice President, Technology Strategy & Development, and Chief of Staff for the Technology division at Monsanto. He has been honored with Monsanto's two top awards for science and technology for inventions in developing insect-resistant transgenic crop plants. He and his team were the first to develop insect-resistant tomato, potato, cotton and corn through the expression of insecticidal genes from Bt. He initiated and led Monsanto's Plant Genomics Research Program, is the inventor on key patents related to insect-resistant plants, an author of more than 25 scientific publications and an invited speaker at numerous national and international symposia.

Dr. Ganesh M Kishore is Managing Director of Burrill & Company. Earlier he was Vice President of Science and Technology and Chief Biotechnology Officer of DuPont. Kishore has contributed significantly to the discovery, development and commercialization of agri-bio products, manufacturing processes for Nutrasweet and transforming Monsanto Company from a chemical giant into a leading food and nutrition company. He has served as an Advisor to National Science Committees in many Asian countries and venture capital groups.

Dr. Gretchen Kalonji, Director of International Strategy Development for the University of California, is working closely with partners in China, Canada, India, Mexico and Africa. Multiple awards and honors including Presidential Young Investigator Award, George E. Westinghouse Award, and NSF Director's award for Distinguished Teaching Scholar have recognized Prof. Kalonji's work, both in Materials Science and in transforming higher education. Before coming to UC, she was a Professor at the University of Washington and Associate Professor at MIT.

Dr. Janaki Akella is a Principal in McKinsey & Company's Business Technology Office in Silicon Valley. She has served several Fortune 500 Companies, transforming their businesses using Technology. Janaki has also worked with organizations such as Gates and Dell Foundations on improving education using Technology. Before joining McKinsey, she worked at Hewlett Packard Co. Janaki received a Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University and has published papers in prestigious journals.

Mr. James Morgan has been the Chairman of Applied Materials since 1987 and was its Chief Executive Officer from 1977 to 1983. With one of the longest tenures of any Fortune 500 CEO, Mr. Morgan is a recipient of the 1996 National Medal of Technology. He has received many other awards and honors – notable among those are: Spirit of Silicon Valley Lifetime Achievement Award 2006 and Robert N. Noyce Award 2006. He is currently Vice Chairman of the President's Export Council, Co-chair of the U.S.-Japan Private Sector Government Commission and is on the Advisory Board of Center for Science, Technology and Society.

Speakers

Mr. Lakshmi Narayanan, a member of the Board of Directors of Cognizant, has played a leading role in the global information technology industry for more than 25 years, managing divisions and business units in Europe, India and the United States. He holds a B.S. and M.S. in Science and Electronics from Bangalore University and an MBA from the Indian Institute of Science and began his career at Tata Consultancy Services.

Dr. Mark Pinto is the Chief Technology Officer, Senior Vice President and General Manager of the New Business and New Products Group at Applied Materials. Appointed to the role in January 2004, Dr. Pinto is responsible for Applied's technology direction, its advanced R&D programs and for developing new business opportunities. He is also responsible for IP licensing business and serves as Chairman of Applied's Venture Investment Committee. Previously, Dr. Pinto spent 19 years with Bell Labs and the Lucent Microelectronics Group, later to become Agere Systems. He was named Bell Labs Fellow. Dr. Pinto is also a Fellow of IEEE and has authored or co-authored more than 150 papers and has 9 patents.

Prof. Mohan is the Principal Investigator of a major programme,
"Centre of Excellence for Nanoelectronics" and also a Professor in the Department of Instrumentation at the Indian Institute of Science. He has recently been made the Chairman, Alumni Cell of IISc, which acts as a single window for interaction with the alumni of the Institute and also the Alumni Association. He was previously Director of Central Scientific Instrument Organisation (CSIO) and Chief Executive of SID at IISc.

Mr. Navin Chaddha is the Managing Director, Mayfield Fund. He holds an
MS degree in electrical engineering from Stanford University. He is a Charter Member of TiE and AAMA; serves on the Board of TiE and is a Global Leader of Tomorrow Member of the World Economic Forum. Navin is on the Forbes Midas List as a top 100 dealmaker in 2007 and he won the IIT Alumni Award in 2006. He holds over 35 patents and has been recognized as an industry thought leader by Aspatore Books, Forbes, Fortune, Upside and The Wall Street Journal.

Dr. Parveen Gupta is currently Senior Vice President at Satyam Computer Services, a leading global IT, Engineering and BPO Consulting Services Company. He co-founded Mylex in 1990, where he started the storage technology division and grew it to a $200 million business. IBM acquired it in 1999. Prior to Mylex, Parveen held senior marketing and engineering management positions at HCL, Zilog, United Technologies, Mostek, TCS and Astronautics. Dr. Gupta is also a founding Charter Member of TiE.

Dr. Parveen Jain was EVP of CorpDev, Strategy & BD at McAfee. Earlier, he was founder and CEO of IntruVert Networks (a network security company acquired by McAfee) and CTI for power plant diagnosis and optimization. His experience includes 15+ years in power & process industry and senior management roles in companies delivering fiber optic networking equipment, data mining and aggregation and web-based ASP tools. Parveen has a Ph.D.-NucE from UIUC, has received several awards including Hay Gold Medal for IISc's Best BE-ET Student and Jain Ratna Award and has authored 50+ publications. He serves on several startup boards and holds executive positions with several religious and social organizations.

Rajagopala Chidambaram, a distinguished neutron crystallographer, is the Principal Scientific Adviser to the Government of India. He was previously Director of Bhabha Atomic Research Centre and Chairman of India's Atomic Energy Commission. He is a Fellow of TWAS and all the major science academies of India and has won many awards. His entire research work was performed in India. He was Chairman of the Board of Governors of the International Atomic Energy Agency (IAEA) during 1994-95 and till recently, Vice-President of the International Union of Crystallography.

Speakers

Professor Ramakrishna ("**Ram**") **Akella** is the Director, Center for Knowledge, Information Systems, and Management of Technology (KISMT), University of California at Silicon Valley Center/ Santa Cruz; and has served as Director/Chair, TIM and GEM. He has a B. Tech. from IIT Madras and Ph.D. from IISc/CSA. His postdoctoral and faculty appointments include Harvard, MIT (EECS/LIDS), Carnegie Mellon, Berkeley and Stanford. His research integrates data/text/semantic mining, search, and machine learning with business management and services and has been implemented in dozens of facilities worldwide and altered industry practice. His students have gone on to become department chairs and executives of major universities, corporations and startups. In addition to major editorial boards he has served on, he is on the Boards/Councils of Unit Trust of India (UTI Ventures) Ventures, E-Soft, Service Research and Innovation (SRII), Yield Dynamics, Co-Chair, CA Governor's Delegation to India and a Charter Member of TIE. He has worked extensively with major firms in the US, Europe, Asia, Japan, Korea and Taiwan, received awards, including from IBM, AMD and KLA, and lectured at major institutions.

Dr. Rathin C. Das is the President of Affitech USA Inc. and a specialist in biotherapeutics and therapeutic antibody research and has over two decades of experience in the pharmaceutical and biotechnology industry. He has held key research management positions at Bayer Corporation in the United States and at Bayer AG in Germany. Dr. Das has been working for Affitech since 2000 and prior to that he was the Vice President of Business Development of Etiogen Pharmaceutical. He is also the Editor of the biotechnology trade publication, *American Biotechnology Laboratory.*

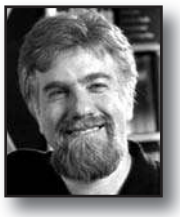
Prof. Robert J. Birgeneau is the Chancellor of the University of California, Berkeley, and an internationally distinguished physicist. Before coming to Berkeley, Birgeneau was the President of the University of Toronto and Dean of the School of Science at the Massachusetts Institute of Technology. His commitment to diversity and equity in the academic community is well known. He is a foreign associate of the National Academy of Sciences, USA, and has received many awards for teaching and research. In 2006, Prof. Birgeneau received a special Founders Award from the American Academy of Arts and Sciences.

Sanjay Subhedar founded Storm Ventures in October 2000. He was previously the CEO/CFO at E-TEK Dynamics, Inc. Prior to that Sanjay was CFO at Stratacom and Vice President of Cisco's WAN business. He is on the Board of Trustees of Palo Alto Medical Foundation, Board of Directors of The Indiana University Foundation and the Governing Board of the Indian School of Business. He holds a B.S. from the University of Bombay and an M.B.A. from Indiana University.

Raj Shah is an Engineering Director at Google. Prior to joining Google, Raj was Vice President of Engineering and responsible for the creation and oversight of the Indian subsidiary at Ketera Technologies (provider of on-demand spend management and e-procurement solutions), a KPCB funded start-up. Prior to Ketera, Raj was founder and CEO of 123Signup, a leading provider of on-demand event registration and membership management services, where he continues to be Chairman. He created and managed Informix India Development Center, and was VP of Engineering at Independence Technologies – which brought Tuxedo out of (then) Bell labs and made it a commercial product. The Company was successfully sold to BEA. Raj is an active charter member of TiE, and has served on many committees.

Sriram Viswanathan is Vice President of Intel Capital and General Manager of the WiMAX program office and is responsible for investments worldwide in the mobile area, the mobile content and services sector, mobile communications sector and mobile platforms sector. He has a Bachelor's degree in Computer Science and Automation from the Indian Institute of Science and a Master's degree from UCLA Anderson School of Business.

Speakers



Ted Goldstein is an innovator in electronic commerce, programming environments, smart cards, and now, biotechnology. Ted is currently Vice President of Software at Theranos, a company that is dedicated to redefining healthcare by bringing automated broad spectrum blood testing to the home. Previously, as Vice President of Developer Technologies at Apple, Inc. Ted has also contributed to the C++ language standard and Java language development. Ted has been key in launching several startups: Nanobiz, Brodia, and ParcPlace Systems—a spin-off of Xerox's Palo Alto Research Center. Ted holds 9 software and hardware patents and a Bachelor of Arts degree in Computer and Information Science from the University of California at Santa Cruz.

Venkata Palle is Head of Discovery Chemistry at Advinus Therapeutics Pvt Ltd (Pune, India). Prior to joining Advinus Therapeutics, Dr. Palle played a leading role in Medicinal Chemistry in the drug discovery efforts at Ranbaxy Laboratories (Gurgoan, India) and CV Therapeutics (Palo Alto, CA). He has developed a number of drug candidates that are in various stages of clinical development. He received his Ph.D. in Organic Chemistry from IISc and conducted post-doctoral work at the University of Rhode Island (Kingston, Rhode Island).

Vijay Chandru (Ph.D., MIT, 1982) is an academic-turned-entrepreneur. Vijay's research in computational mathematics over two decades at Purdue University and IISc has led to over 60 journal articles and a book in computational logic. Strand Life Sciences, a leading silico life sciences company he founded was recently recognized as an IT Innovator by NASSCOM in 2006 and as a Technology Pioneer by the World Economic Forum in 2007. A Fellow of the Indian Academy of Sciences, Vijay also founded PicoPeta Simputers.

Vish Mishra is a venture capitalist with Clearstone Venture Partners since 2002. He has over 30 years of leadership and management experience in the technology industry covering computers, internet, communication and software. He has served as a founder of Telera, a voice web infrastructure company funded by Accel and Sequoia (sold to Alcatel) and co-founder of Excelan (sold to Novell), generating over $1B in revenues. Vish has also served as a CEO and Director of several startup companies.

Jugalbandi

Arvind Lakshmikanthan and Prasad Jogelekar will come together to make music and magic on the spot in an instrumental Jugalbandhi. Supporting them on Tabla is Ravi Gutala and on Mrudangam is Karthik. The origin of Jugalbandi is thought to have been in a spirit competition where musical titans clashed to showcase their knowledge by improvising the structure and style in classical Indian music. But today's Jugalbandi provides a rare treat where the artists echo and complement one another by typically elaborating on the same Ragam and bringing out the uniqueness and nuances of different (in this case Hindustani and Carnatic) styles.

Arvind Lakshmikanthan, raised in a family steeped in tradition and cultural values, was introduced to music at an early age. He came under the tutelage of Smt Lalgudi Srimathi Brahmanandam, sister of Sri Lalgudi G.Jayaraman. Through devotion and meticulous practice, Arvind gained expertise in raga elaboration, rendition of compositions and in providing skillful accompaniment. He has performed extensively in India and in the US as a soloist and as an accompanist. Arvind has accompanied several acclaimed musicians including Nedunuri Krishnamurthi, O.S. Thiagarajan, Unnikrishnan and Bombay Jayasri.

Dr. Prasad Jogalekar started his musical training from his parents. At age 10 he started sitar lessons with Mr and Mrs Phadke, Pune, and later from Ustad Abdul Halim Jaffer Khan. He learnt other sitar styles from Pandit Partho Chatterjee and Ustad Shahid Parvez. Prasad has played on All India Radio and has given several live concerts in India as well as the U.S. He has played with San Jose Chamber orchestra in their "Winter" concert series.

Karthik started learning the Mridangam at the age of 9, from Vidwan Sri H.S.Sudhindra, in Bangalore. Karthik has learnt vocal music from his mother Smt. Girija Gopalratnam, and Vidushi Smt. Neela Ramagopal. Karthik has given numerous Mridangam performances in Bangalore, and in the U.S. He was privileged to come under the guidance of Vidushi Smt. Sreevidhya Chandramouli, a renowned Veena artist. Vidushi Sreevidhya's artistic and aesthetic guidance have been instrumental in mentoring Karthik's growth as a musician - both as a Mridangist as well as a vocalist.

Ravi Gutala has been initiated at a very early age into Tabla by Shri P.Anjaiah, a senior staff artist at AIR, Hyderabad. He has been studying Tabla under Maestro Swapan Chaudhuri. Ravi is a recipient of All India National Talent Search Scholarship. He had performed at AIR, Hyderabad. He has accompanied many artists such as Pt. Jasraj, Smt.Lakshmi Shankar, Dr.L.Subramaniam, Dr.Rajeev Taranath, Pt.Buddhaditya Mukherjee, Smt.Veena Sahasrabuddhe, Ustad Shujaat Khan, Shri Sanjeev Abhayankar, Master Shashank etc. He has 8 CD recordings and 2 cassette recordings to his credit. He also has been teaching Tabla to a number of aspiring students in the Bay Area.

Entertainment

Artists

Jyothi Lakkaraju obtained her training in Kuchipudi from the Guru Sri Chinta Radha Krishna Murthy and his son Sri Chinta Adinarayana Sarma, and advanced training from Dr. Uma Rama Rao. Jyothi has given over 300 performances all over the world and has received awards such as "Singara Mani" and "Nrithya Bharathi". She has also choreographed many ballets such as Ritusambhavam, Mahisasuramardhini, Sugunamala, Prasanna Ashtalakshmi, & Usha Kalyanam. Jyothi is the founder and the artistic director of Natyalaya school of Kuchipudi dance.

Anuradha Nag had her training in kathak from Nataraj Parimal Krishna and later from the legendary guru Padmavibushan Pandit Birju Maharaj and his disciple Pandit Vijai Shankar. She stood 1st in the Pashchim Banga Nikhil Bharatiyo Competition.She was awarded the title of "Sringar Mani". She has performed extensively in prestigious music and dance festivals throughout the world. She was an artist for the Sangeet Natak Akademi and the Indian Council of Cultural Relations. Anuradha Nag has choreographed ballets in many traditional and contemporary themes like Jhalkia, Om, Rituranga, Khoj, Chitrangshu, and Rabindranath Tagore's *Khuditopasan*. Anuradha is the founder and artistic director of Tarangini School of Kathak.

Vidhya Subramanian learnt Bharatanatyam in the traditional Vazhuvoor style from the Guru Sri S.K.Rajarathnam and the abhinaya exponent Smt. Kalanidhi Narayanan. She has given over 250 performances all over the world and had the honor of performing before the Indian President and Prime Minister. She received prestigious awards such as the M.G.R. award, 'Singar Mani', 'Natya Arasi' , 'Yuva Kala Bharati' and 'Nadana Māmani'. She has produced several dance dramas including 'Shakuntalam', 'Silappadikaram', Bharati in 'Bharatam and Living'. Vidhya is the founder and the artistic director of Lasya Dance Company for Bharatanatyam.

Concept and Coordination:
Aparna Munukutla Gunupudi

Choreography:
Kuchipudi - Jyoti Lakkaraju
Kathak - Anuradha Nag
Bharatanatyam - Vidhya Subramanian

Orchestra

	Hindustani style	**Carnatic style**
	Jaya Basu - Vocal	Easwar Ramakrishnan – Vocal
	Shubho Nag – Vocal & Narration	Ashwin Krishnakumar - Flute
	Ben Kunin – Sarod	Ramesh Babu – Mrudangam
	Ravi Gutala – Tabla	Anupama Gunupudi – Nattuvangam (Kuchipudi)
	Satarupa Bose Roy – Script	Anuradha Sivaram – Nattuvangam (Bharatanatyam)
		Krishna Subramanian - Narration script
	Lyrics	**Music**
Kathak	Rabindranath Tagore	Rabindranath Tagore & Jayanta Banerjee
Kuchipudi	Aparna Munukutla Gunupudi	Asha Ramesh
Bharatanatyam	R. Radhakrishnan	Asha Ramesh
	Saraswati Vandanam	Pundit Vijai Shankar

Trayādarsa

The Three Visionaries

Act I - Pramukha Trayam, a dance ballet, depicts the life stories and achievements of the three prominent visionaries of India - J.N. Tata, Rabindranath Tagore and Sir C.V. Raman in three prominent dance forms of India – Kuchipudi, Kathak and Bharatanatyam. This ballet begins with an invocation to Saraswati, the goddess of knowledge and fine arts, beautifully choreographed as confluence of the three styles.

Act II - The artistic director/dancer Jyoti Lakkaraju and her students narrate the life story of Tata and his visions in Kuchipudi style. **Jamsetji Nusserwanji Tata** is a remarkable person with a great vision who played an important role in the rebirth of India from its darkest periods. He toured several countries and came to the conclusion that to eradicate poverty and induce economic growth in India establishment of heavy industry, institutions for advanced scientific research and power generation are important. From this realization sprang the three enterprises with which his name is associated – the iron and steel works at Jamshedpur, the hydro electric schemes in Bombay and the Indian Institute of Science at Bangalore which aims at giving Indians opportunity for post graduate education and research, which is second to none in the world.

Act III – The artistic director/dancer Anuradha Nag narrates life, love, knowledge and tenderness of Kavi Rabindranath Tagore in Kathak style. **Rabindranath Tagore** a man of inexplicable talents and creativity, versatile and universal. He was a poet, author and a writer. He is the first Indian to win a Nobel prize in literature for his *Gitanjali*. He had dreamt of an *ashram* thus he established Biswabharati symbolizing the unity amidst diversity and Shantiniketan became the university for the entire human race. Tagore had often felt the trauma of being under the British rule. His immortal verses are the national anthems of India and Bangladesh. *Jana gana mana adhi nayaka jaya hey, bharata bhagya vidhata…* and *Amar sonar bangla ami tomay bhalobashi….* According to Tagore, joy or happiness is God. His understanding of God, the supernatural force, has made us believe that his creative excellence had transported him to the platform of being Gurudev.

Act IV - Artistic Director, Vidhya Subramanian and Lasya Dance Company will present, in Bharatanatyam style, highlights from the life of the great achiever **Chandrasekhara Venkata Raman**, more popularly known as Sir C.V. Raman. He was a great scientist and he was the first and only Indian Nobel Laureate in science. This son of Parvati, born on the banks of Cauvery, was deeply interested in such varied subjects as musical instruments, the various colors of flowers, and diamonds. He was married to Lokasundari. The piece is composed in the format of a varnam portraying a heroine feeling sorry at the absence of Raman's greatness on earth. She talks proudly of his achievements including the discovery of the Raman Effect. She talks about his contribution to education, charity, and oratorical skills. She describes him as the ray of light that analyzed the scattering of light.

Act V - This ballet concludes in praise of the mother land that is fertile with ever flowing rivers, temperate weather and flourishing with prosperity, the song "Vande Mataram", one of the anthems of India, written by Bankim Chandra Chatterjee.

India as Innovation Leader

By Rajgopala Chidambaram

***Rajagopala Chidambaram**, a distinguished neutron crystallographer, is the Principal Scientific Adviser to the Government of India. Earlier, he was the director of Bhabha Atomic Research Centre and Chairman of India's Atomic Energy Commission. He is a Fellow of TWAS and all the major science academies of India and has won many awards. His entire research work was performed in India. He has been Chairman of the Board of Governors of the International Atomic Energy Agency (IAEA) during 1994-95, and till recently Vice-President of the International Union of Crystallography.*

I have said for many years that the two measures of development of a country like India are Per Capita Electricity Consumption and Female Literacy and that these are better measures than the three parameters – per capita GNP, life expectancy at birth and adult literacy – used by the United Nations to define the Human Development Index. If India wants to become an economically developed country, it should become near 100% literate without gender discrimination and there should be a substantial increase, perhaps by a factor of 8 or so, of its electricity production. Female literacy inter alia strongly correlates with infant mortality and birth rate. And per capita electricity production is not only monotonically related to per capita GNP but also correlates strongly with human health.

For sustaining its development, India should simultaneously become scientifically advanced. Here is where a leading scientific institution like the Indian institute of Science, Bangalore, in which I had the privilege of doing my doctoral research, plays an important part. I was fortunate to go from there to Bhabha Atomic Research Centre, which is another prime research and development organization in Science and Technology. In fact, India should now think of going beyond becoming a developed country and aim to become a global innovation leader.

The US wants to retain the global innovation leadership. In a meeting of the Industrial Research Institute on R&D Globalization, which I attended in Tucson in May 2005, the Council on Competitiveness - a private sector initiative - talked about retention of talent, increase of investment and improvement of infrastructure, all these enveloped by leadership. Our attempt to become a global leader, particularly in science & technology area, would require all these inputs.

The biggest problem before the scientific community in India today – perhaps all over the world – is to attract talented young people to careers in science and to retain them there. I have postulated a theorem sometime back, with which all the professors to whom I have talked to are in general agreement: "Given a certain number of senior scientists, the number of research publications from a laboratory is directly proportional to the number and quality of research students". If we succeed in attracting the most talented in science to science, the aim of accelerated growth in the number of our research publications will automatically get solved.

The Steering Committee for Science & Technology for the Eleventh Plan (2007-2012), which I chaired, has devoted considerable portion of its report to this aspect. This report is available in our website: **www.psa.gov.in**. In particular, the Steering Committee has recommended that at the 10+2 stage, talented science students must be offered a 15-years career support programme. In the first five years, a good fellowship while they work towards the M.Sc degree; a substantial fellowship matching the kind of salaries of the same age group in jobs during the 5 years or so as he or she works for the Ph.D; and an assurance of a proper job in a University or any national laboratory for five years after Ph.D. I have spoken to many young people who after winning Silver and Gold medals in International Olympiads for Physics, Chemistry and Mathematics, have given up scientific careers and taken up professional courses because of better career prospects. These young people told me that, if they had before them the 15 years career support programme of the type I mentioned above, they would have stayed in science. Unless this is done, leading institutions like the Indian Institute of Science, Bangalore, and the Bhabha Atomic Research Centre could get depleted of top class

scientists in the future.

The other problem is of young talented engineers not staying in the area of engineering research and technology development, but taking up jobs, going into management or just migrating abroad. In a meeting to strengthen academia-industry interaction held in my office some years ago, it was suggested that leading Corporates when they have placement interviews in academic Institutions and hire graduates, the most talented among them with research potential could be paid job salaries but allowed to do research in an area of interest to the company. The young person should not be compelled to do problem-solving for the company. He should be no different from any other student of the professor. When two professors from two different countries talk, the information exchange is free and the young student is listening. When two company scientists talk, the information exchange is hampered by IPR concerns.

I have paraphrased the modern futurologist Alvin Toffler's famous statement some years ago: "Yesterday Violence was power, today Wealth is power and tomorrow Knowledge will be power" to say that today, more than at any time in history, 'Technology is Power', and this will continue to be so in the foreseeable future. I say this because all the sources of power Toffler mentions have their foundations in technology. Technology domination is sought today both by companies and by countries, in fields as diverse as human genomics and nuclear weapons, through the mechanisms of Intellectual Property Rights and Technology Control Regimes.

India requires a robust and vibrant innovation ecosystem, which implies an education system, which nurtures creativity; an R&D culture and value system which supports both basic research and applied research & technology development; an industry culture which is keen to interact with academia; a bureaucracy which is supportive; a policy framework which encourages young people to enter into scientific careers; and an ability to scan scientific developments in the world and to use technology foresight to select critical technologies in a national perspective. A part of the Innovation Ecosystem is courage to take risks on the part of the scientist and the industry and support of risk-taking by the governmental system. The greater the innovation, higher is the risk in converting it into a marketable product or process; and consequently greater is the support required from the Government, like in the SBIR and ATP programmes of the U.S.

In an article entitled "The Innovation Backlog" in the MIT Review (December 2003-January 2004), Kenan Sahin has written that "Universities and large corporate labs, as innovation sources, are characterized as R&d (big research, small development) organizations. Most companies, with their marketing and production arms, would be d&D (small development, big delivery) enterprises. This lack of a strong connection between these groups is partly responsible for today's innovation backlog (in the U.S.A). Therefore we need more r D&d organizations to bridge the gap. Their main activity is in developing innovation for the market." This has also been a weakness in the Indian S&T system, even more obviously than in the United States. There are initiatives like the Technology Information and Forecasting Assessment Council (TIFAC) of the Department of Science and Technology and the Core Advisory Group for the Automotive Sector (called CAR, though it deals with all automotives from two-wheelers to heavy vehicles) created by my office, which are some of the attempts at developing such linkages. CAR, which has had significant success, encourages pre-competitive applied research, with industry working in a consortium mode. My office has started a similar initiative for the machine tool industry. India requires to strengthen the academia-industry interaction and also to improve on Rural Technology delivery.

Basic Research is a cultural necessity in any civilized country. The highest intellects must be allowed to work on fundamental problems of their choice. In the Eleventh Plan, the Government is going to increase substantially the funding for basic research. In my opinion, some of this research must be directed to areas of future importance to India. This is what I call "Directed Basic Research" and the Steering Committee report indicates such areas, selected in a national perspective.

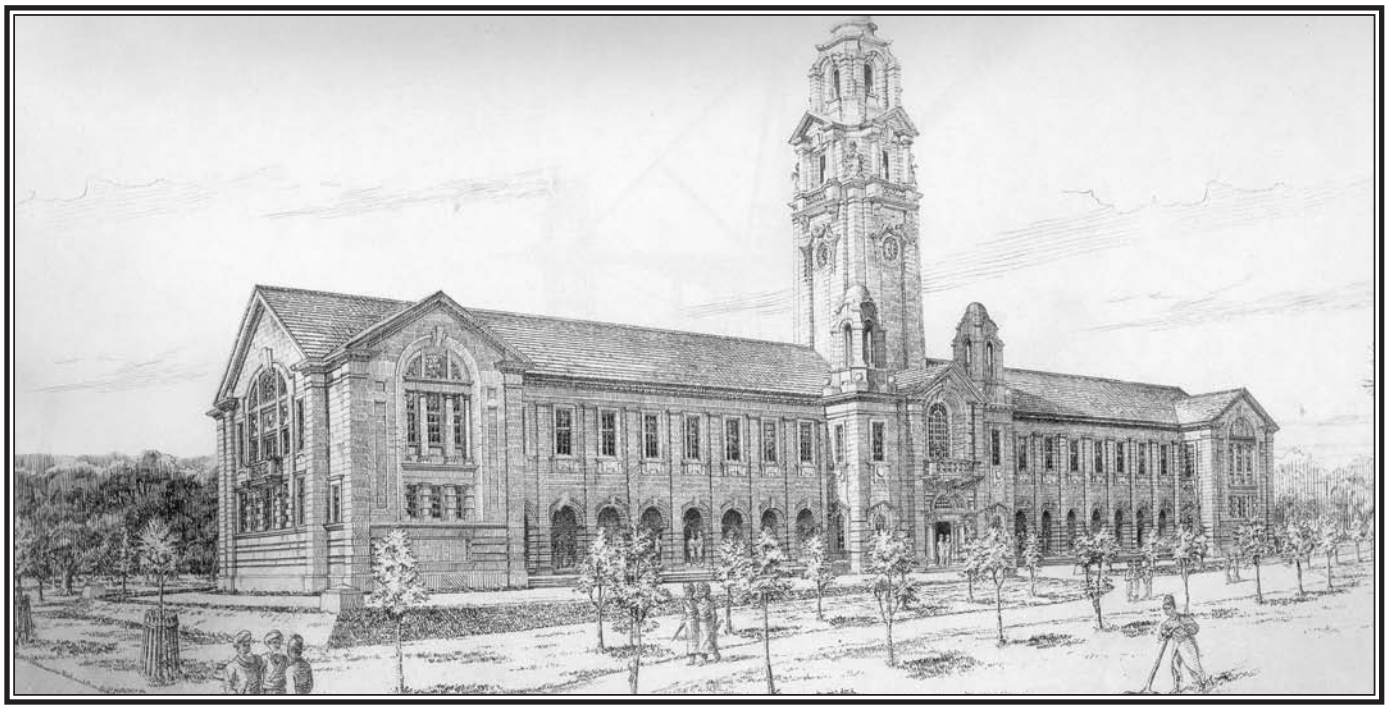
International Cooperation is also extremely important. India participates in international mega-science projects like the Large Hadron Collider being built by CERN in Geneva and has also recently joined the ITER (the International Thermonuclear Experimental Reactor) co-operative programme. Today India wants international cooperation on an equal partner basis. India is one of the two countries (the other is China) where nuclear power production is growing rapidly due to high energy demand. So knowledge management in nuclear technology is not a problem in India, unlike in those countries where the nuclear power development is currently stagnating. Driven by the global climate change threat, there is a nuclear renaissance emerging

in many countries including the U.S. I am sure that, in nuclear technology, while India needs the world in the short term, the world will need India in the long term. I must also mention in this context that I have been defining 'self-reliance' for many years now, not as self-sufficiency, but as "immunity against technology denial", particularly in high-technology areas.

The Science and Technology system in India consists of many components like Human Resource Development, Research & Development with prioritization, academia-industry interaction, leveraging international cooperation, etc. Each of these components requires synergy among the concerned parties and every such synergetic effort gives India a momentum for development. But momentum is a vector. For India's rapid development, all the vectors must point in the same direction. That is Coherence. Synergy in every effort and Coherence among all the efforts! This is what I defined some years back as "Coherent Synergy".

India looks at Scientists and Technologists of Indian Origin (STIO's) as a precious resource, and the Department of Science and Technology of the Government of India has as excellent STIO program. The Alumni of the Indian Institute of Science in North America can play a crucial role in the challenging task of making India an innovation leader in Science and Technology.

India can become a global Innovation Leader, provided we use technology foresight to make the right technology choices in a national perspective, provided we have a robust innovation ecosystem and provided we introduce 'Coherent Synergy' in our S&T system-related activities.



An Artist's Sketch of the Institute's Main Building
(Referred to as "Library Building" in Early Documents)

IISc Alumni Association of North America

Thanks

Constructive Philanthropy

By Venkateswara Rao

***Venkateswara Rao** received his B.E. in Metallurgy from the Indian Institute of Science (1965-68), and Ph.D. from the Banaras Hindu University. After a brief stint as lecturer in the Regional Engineering College, Tiruchirapalli he joined the National Metallurgical Laboratory, Jamshedpur, where he pioneered the bulk production of rapidly solidified alloys. His research interests are in the areas of Rapid Solidification Processing, Technology of Aluminium alloys, and Net-shape in-situ composites.*

I came to the USA to attend the IISc Global Conference and Alumni Reunion at the invitation of one of the organizers, Subba Rao Gunupudi. One day after a sumptuous lunch, I came across a book chronicling biographical details of Sri Jamsetji Nusserwanji Tata, the Founder of the Indian Institute of Science, popularly called the Tata Institute in Bangalore. The book was written by Frank Harris, an Englishman and published by Oxford University Press in 1925 and reprinted by Blackie & Son in 1958 with minor editorial changes. While the narrative was deeply engrossing what stuck me deeply was the philosophy of constructive philanthropy enunciated by J N Tata which led to the establishment of our institute.

Jamsetji Nusserwanji Tata

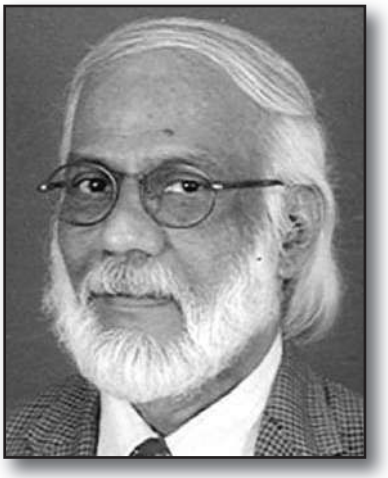
Though J N Tata amassed enormous wealth from the cotton mills and trade, he was also generous in assistance to others. Mr. Tata was of the opinion that though charity was an affair of the heart, it could not be given without proper investigation to render temporary relief to the inefficient. He believed that much of the poverty around him was due to lack of opportunity and he had experienced the waste caused by inefficient workmen. He firmly believed that to alleviate poverty in the country; development of the industry by the application of science was of paramount importance. To achieve this in Sept 1898, he announced the gift of £200,000 for the setting up and support of an University or Institute of Research. While his proposal was widely acclaimed by many executives of the society, a few among his Parsee community were reported to have sounded a discordant note, that a great fortune had been diverted from them. The reaction of Mr. J N Tata to this criticism elucidated his principle of constructive philanthropy. The following is an excerpt from the book.

"There is one kind of charity, common enough among us, and which is certainly a good thing, though I do not think it is the best thing we can have. It is that patchwork philanthropy which clothes the ragged, feeds the poor, and heals the sick and halt. I am far from decrying the noble spirit which seeks to help a poor or suffering fellow-being. But charities of the hospital and poor asylum kind are comparatively more common and fashionable among us. **What advances a nation or community is not so much to prop up its weakest and most helpless members, as to lift up the best and most gifted so as to make them of the greatest service to the country.** I prefer this constructive philanthropy which seeks to educate and develop the faculties of the best of our young men". The constructive philanthropy was the guiding principle for the establishment of the Indian Institute of Science and other Tata enterprises.

The proof for Tata's principle of Constructive Philanthropy is now seen in the contributions of the IISc Alumni in every scientific discipline. As the Centenary year of the establishment of the Institute is fast approaching it is heartening to note that the Global Conference is trying to bring many of the alumni on a single platform to fulfill Jamsetji's vision.

The Biotech Route for IISc

By G.Padmanaban



***Professor G. Padmanaban** is essentially a home-grown scientist and was the first student of IISc to have served as its director (1994-1998). Presently, he is continuing to carry out his research at IISc on malaria as the first Distinguished Biotechnologist of the country, awarded by DBT. He is intimately linked with the growth of several facets of biotechnology and Life Sciences in the country.*

At times, even the government of India takes the right decision at the right time! One such example is the creation of the National Biotechnology Board (NBTB) in the Department of Science & Technology (DST) in 1982, which became a full-fledged Department of Biotechnology (DBT) in 1986. I have been fortunate to be part of the evolution of Biotechnology in the country.

Consistent support to modern life science research by DBT, DST and other agencies for over two decades has paid rich dividends. There are over 200 groups in the country in over two dozen institutions capable of top quality research in modern life sciences in the country as evidenced by publications in high impact factor journals. This stands out in a background of perceived static performance in other areas of science. The main concern is that the contribution of universities to this effort is average, with the thrusts mainly coming from national and agency laboratories.

In terms of applications, the whole of 1990s was a learning experience. All the claims of the development of molecular diagnostics (including my own) for a variety of diseases did not translate into products in the field. The scientists did not know how to make the lab-to-land transition and the industry knew only to import components and sell the products with a nice wrapper.

The new millennium has been different. Consistent efforts by the government, especially DBT and CSIR, to create networks and bring about academia-industry tie-up have started giving results. Many biopharmaceuticals, including modern vaccines (e.g. recombinant hepatitis B vaccine, interferons, GM-CSF, streptokinase, insulin, diagnostics, etc.), have become commercial products and there are over 300 biotech companies in India and the list is growing. Most of the products are biogenerics and these are relevant to India's needs. For example, indigenous manufacture of recombinant hepatitis B vaccine has led to a ten-fold fall in price in 2-3 years! Attempts are also underway to generate innovative products (e.g. DNA vaccines, nanomaterial-based diagnostics and drug delivery systems) and this has automatically led to industry seeking the help of academia. Although, one has still to go a long way, the enthusiasm and excitement are palpable. Nanotechnology, Stem Cell therapy, Bioinformatics, GMP manufacture IPR, etc. are not just remaining as buzz words, but tremendous activity is in place and I believe one would see the results in less than 5 years time.

As against the progress in the health sector, I must confess that the application of modern biotechnology to agriculture is lagging behind considerably. Even the non-controversial area of marker-assisted breeding of crops is only at the level of research. I am a votary of transgenic technology for the improvement of agriculture. There are tremendous opportunities to go beyond Bt cotton, so that food crops resistant to abiotic stresses and with improved nutritive quality can become a reality. I honestly believe that activists have done a disservice in this regard with exaggerated concerns and doomsday predictions. The premier institution that should give the lead, Indian Council of Agriculture Research (ICAR), is sitting on the fence. It is only the indigenous effort that can challenge the dominance of MNCs and I am looking forward to a day when all the indigenous efforts would come out of the glass houses and make it to the field.

IISc has been a part of the biotech revolution of the country as has been the case with every other major S & T initiative of the country. It has also been a beneficiary of consistent support from DBT, DST and other agencies. IISc was the earliest

institution to have started a Centre for Genetic Engineering. Major research programmes on Mycobacterium tuberculosis, pathogenic viruses, malaria parasite, cancer biology, etc. in an environment of considerable strengths in molecular biology, structural biology and cell biology have led to voluminous publications of merit. Its role as a major contributor to high quality human resource in the country is also well recognized. It produces around 200 Ph.Ds a year that is perhaps, around 15% of the total Ph.Ds produced in the country. The country needs 3 to 4 times more Ph.Ds to keep pace with the modern developments.

As a laid-back institution, IISc does not project much of its contribution in Biotech applications. But, IISc has contributed to the development of recombinant hepatitis B vaccine, DNA vaccine against rabies, a rotavirus vaccine under trial, candidate tuberculosis vaccines, drug candidates for malaria under trial and modern diagnostics including for HIV. At least, 40% of the faculty in the Biology Division would have an industry linkage and this is a sea-change as to what it was 10 years ago. I do believe that IISc is the right place for innovation and the institution can play a great role not only as a mentor to generate high quality human resource, but also as an incubator to generate innovative products and processes.

I want to end this piece with a suggestion. Great institutions with a hoary past such as the IISc need to reinvent and rejuvenate themselves periodically. In the area of life sciences, many new and modern institutions have come up in the country. These are compact, well funded and compete with the best not only in publishing papers, but also in filing patents and interacting with industry. It would not be easy for IISc to retain its pre-eminent position, unless it is alive to the changing contours of scientific research in the country and the demands and expectations of the funding agencies. The centenary year would provide an occasion for introspection.

Gandhiji at the Institute, 1937

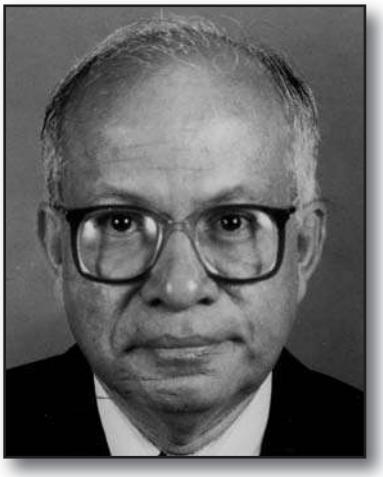
(Contributed By R Raghavachari)

Left to Right: Sir C.V. Raman, Gandhiji, Sardar Vallabh Bhai Patel

Left to Right: Sir C.V. Raman, F.W. Aston, Sir James Jeans

The Colour and Sound of Metals

By S. Ranganathan



***Srinivasa Ranganathan** obtained his B E in Metallurgy from IISc in 1962 and Ph D from Cambridge University, UK in 1965. After serving from 1967 to 1981 on the faculty of the Banaras Hindu University, he returned to the Institute in 1981. After serving as Chairman of the Department and the Division of Mechanical Sciences, he is currently Honorary Professor and INAE Distinguished Professor at IISC, NIAS and JNCASR. His research interests include physical metallurgy and materials heritage. He is a Fellow of all four Science and Engineering Academies of India as well the Academy of Sciences of the Developing World.*

I had just completed in 1960 the three years Honours Course in Chemistry from Loyola College, Madras, and applied for admission to the two year B.E. course in Metallurgy at the Indian Institute of Science. I was pleasantly surprised to receive a telegram almost by return intimating that I had secured admission. On arriving at the Institute I learned with pride that all University first rankers were offered automatic admissions. This turned into a mild shock soon, as I noted that my batch of 24 students had at least six such rank holders from Physics and Chemistry from the Universities in Karnataka, Kerala, Tamilnadu and Orissa. It was refreshing that the class represented a microcosm of India - I made friends with Ahuja, Raheja, Mohanty, Joshi, Iyengar, Borle, et al.

The Department had a staff of 12. Its entire focus was on teaching the two-year course in an intensive fashion. We came to the Department at 9.00 AM every day to learn and were not disappointed. If T R Anantharaman used colour chalks to separate alpha and beta brasses in Cu-Zn phase diagrams, K P Abraham taught us fugacity and activity and introduced us gently to the science of thermodynamics. P Rama Rao taught us the elements of electron theory of metals - this exposition left us spell bound. In fact almost all the classes were enjoyable, though the surprise test were not, nor was drawing the blast furnace to scale.

The Department even then had an electron microscope - perhaps the first in India. We were not taught electron microscopy or the theory of dislocations - two major developments in the late fifties. Nevertheless a solid foundation in all branches of metallurgy was given so that we could contribute to these new areas.

Jawaharlal Nehru had a vision that the steel mills of India will be its modern temples. I took practical training at Rourkela Steel Plant. I remember arriving late at night at Rourkela station, sleeping on the platform and waking up to watch with thrill fumes from the LD converter - one of the earliest of its kind in the world.

Four of us did a project on X-ray line shape analysis of filings. It was our first introduction to research under the guidance of T R Anantharaman and P Rama Rao. I read the journals and was most impressed to read a paper in Acta Metallurgica on X-ray line breadth analysis in deformed Uranium by R Krishnan, V S Arunachalam and M K Asundi. I was again inspired to read papers by Cyril Stanley Smith. We were encouraged to give seminars. I spoke on the shape of grains.

The Campus was green and the buildings were sparse. Even though the current gender balance was not there, the total ambience was seductive. Chess and social service occupied some of the free hours left after completing assignments. I believe that we assimilated a great deal in two years enough to stand us in good stead in several leading Universities in the West to which the graduating class flocked at that time.

I had offers of admission to two Universities of Cambridge separated by the Atlantic Ocean. I offered to work as a research assistant under Professor A M Gaudin but do research in physical metallurgy. As he did not agree, I accepted the offer from Professor Alan Cottrell to start looking at grain boundaries in the field-ion microscope.

When I returned to the Department in 1981 after 14 years at Varanasi, it was a very different Department with multi-faceted activities of teaching, research and consultancy, set to blossom soon as a Centre for Advanced Study. New research areas in quasicrystals, process modeling, processing maps and bioleaching are some of the research themes pioneered in the eighties by the faculty. In the nineties the department played

a leading role due to the national changes from the swirling winds of liberalization and globalization. The Department has developed strong links with industries, most notably with Bharat Gold Fields and Jindal Iron and Steel Ltd. Again a new era dawned with overseas links. The first major one was involving Norsk Hydro and The Norwegian University of Science and Technology. It covered several aspects such as faculty and student exchanges. In term of financial outlay it was one of the major programmes at IISc, infusing life into the nascent Society for Innovation and Development. Again, when General Motors, USA wanted to establish research cooperation, it was the Department of Metallurgy, which played the role of the midwife. When Boeing Company wanted a strategic partnership with IISc, the first with an educational institution in Asia, it was the department which played a pivotal role. It will be seen that many of the programmes revolve around metals, automobiles and aviation. It is in many ways the fruition of a visionary step taken by Sir M Visvesvaraiah. As President of the Court in 1942 he pleaded for the introduction of the disciplines of metallurgy, internal combustion engineering and aeronautics. This was a bold and imaginative step. These past sixty years have seen the blossoming of these three areas.

Metallurgy is one of the oldest technologies. Its scientific evolution as a science showed that the paradigm of structure–processing–properties can be applied to all kinds of materials such as ceramics, polymers and composites. Taking cognizance of this the Department has been rechristened as the Department of Materials Engineering in 2006. The disruptive development of nanoscience has again been addressed by the department. Faculty has played an important role in nurturing the Institute Nanoscience Initiative. In nanoscience imaging and moving atoms play a crucial role. Here again the faculty have been responsible for development of state-of-the art electron microscope facilities. The seeds for this go back to the fifties when the first electron microscope in India was acquired by the Department. It is now arguably a world class department. As always some gains are offset by some losses. To me, however, the Department continues to strive for excellence. It is, in the poet's words - like a fountain - ever changing and constant.

Beautiful Hostel Blocks

Computer Science, System Science, and Information Technology: *Beacons for Contemporary Economic Development in India*

C.E. Veni Madhavan, M.Narasimha Murty, and Y. Narahari

C.E. Veni Madhavan *is currently a Professor at the Department of Computer Science and Automation, IISc. He completed his Ph D in the School of Automation, IISc, in 1975. He is a theoretical computer scientist and his current research interests are in cognitive science and cryptography.*

M. Narasimha Murty *is a Professor and currently the chairman of the Department of Computer Science and Automation, IISc. He completed his B.E. (EE) in 1976, M.E. (School of Automation) in 1978, and PhD in Computer Science in 1981, all at IISc. His research interests are in pattern recognition, data mining, and machine learning.*

Y. Narahari *is currently a Professor at the Department of Computer Science and Automation. He completed his B.E. (ECE) in 1982, M.E. (School of Automation) in 1984, and PhD in Computer Science in 1988, all at IISc. His research interests are in game theory and electronic commerce.*

This article provides a glimpse of the inspirational role played by the Indian Institute of Science in the key areas of Computer Science, Information Technology, and System Science and Automation during the past 35 years.

1. A Brief History

The Computer Science, Information Technology, and System Science and Automation activities at the Indian Institute of Science were initiated in a major way with the launching of a new Department, School of Automation, in 1969. The Department was rechristened as the Department of Computer Science and Automation (CSA) in the early 1980s. Ever since its inception in 1969, the Department has been a pioneering academic center in the country for higher education, research, and development in the areas of Computer Science, System Science, and Information Technology. From the days of analog and digital computers and their combined versions of hybrid computers, the Department has been carrying out research, development, and teaching activities. It has assiduously pursued its mission of carrying out leading-edge research in both foundational and contemporary problems. The Department is working closely with other departments of IISc, namely, SERC (Supercomputer Education and Research Centre), CEDT (Centre for Electronics Design and Technology), EE (Electrical Engineering), and ECE (Electrical Communication Engineering) in research and teaching activities in computer science, system science, and information technology.

2. Research Profile

The Department offers two research based programmes: (1) Ph D and (2) M.Sc. (Engineering). Current research can be categorized into three major areas: Theoretical Computer Science, Computer Systems, and Intelligent Systems. The Department has set high standards of research in topics such as algorithms, coding theory, cryptography, graph theory, formal verification, computational geometry, compilers, databases, energy aware computing, graphics and visualization, operating systems, storage area networks, computer architecture, performance modeling, electronic commerce, game theory and mechanism design, bioinformatics, machine learning, pattern recognition, data mining, and stochastic control.

The Department has maintained an excellent tradition of publishing high quality papers in high impact journals and top tier conferences over the years. Many of these papers have reported excellent citation numbers and several of them have received Best Paper Awards. For example, the 23 most cited papers authored by CSA faculty members have a total citation count of 4646 as of February 2007 (Source: www.scholar.google.com). These include both journal publications and refereed conference publications.

3. Involvement with Government Agencies and the Public Sector

The Department has contributed with vigor in many nationally important projects in the areas of Computer Science and System Science. This has resulted in many successful research engagements with agencies and labs such as CAIR, CASSA, DRDL, ADA, ISRO, BARC, and CDAC.

The Department faculty have actively engaged themselves in policy making project review, and advisory activities of important Government agencies such as the Ministry of Communications and Information Technology, Department of Science and Technology, Defense Research and Development Organization, Indian Space Research Organization, the Ministry of Human Resource Development, and the Karnataka State Government. The alumni and faculty of the Department have served as Directors of National Labs such as NRSA (National Remote Sensing Agency), CAIR (Centre for Artificial Intelligence and Robotics), and SAG (Special Applications Group, DRDO). A large number of the alumni of the Department hold key positions in National Research Laboratories.

4. Collaborative R & D with the Private Sector

The Department has maintained a strong relationship with the industry in general and the software industry in particular. A large number of R & D projects have been successfully completed in collaboration with high-end companies. The companies include: Texas Instruments, TRDDC, Intel, GM R & D, Microsoft Research, Infosys Technologies, Satyam Computer Systems, AOL, Brocade, Novell, and Nokia. Research labs and companies such as IBM IRL, Bell Labs, Infosys, and Phillips have set up research fellowships at the Department. Intel funded in 2000 a major laboratory, the Laboratory for Internet Technologies and Electronic Commerce, at the Department for supporting education and research in this area.

5. Inspiration for New Companies

The Department has played an inspirational role for the setting up of several successful companies. The IT Major Wipro Technologies had its modest beginnings in one of the research laboratories of the department. The Texas Instruments, which was the first significant MNC to set up R & D operations in India, essentially started their operations from the portals of the department. The companies Integra Micro Systems and Jataayusoft have been championed by the Department Alumni. The more recent companies, Picopeta Simputers and Strand Life Sciences were initiated by four of the departmental faculty. The company Ittiam Systems, which has made a niche for itself in a very short time, was started by an alumnus of the department. The company Aalayance Inc. was also founded by an alumnus of the Department. Several other companies, both in India and abroad, have been founded by the Department alumni.

6. Teaching and Education

The academic programmes of the Department are highly innovative and keenly sought after. The Department has maintained an excellent reputation for high quality offering of M.E. programmes and Computer Science subjects. The Department offers two M.E. programmes with specialization in various areas of Computer Science: (1) Computer Science and Engineering (2) Systems Science and Automation. The M.E. programmes of the Department attract highly talented undergraduates from all over India; in fact, it has become the number one destination in the country for students planning to pursue higher studies and research in Computer Science.

Several book-writing projects have been undertaken by the faculty as a culmination of offering of courses. As many as 20 textbooks have been offered by the Department faculty in the areas of Computer Science, System Science, and Information Technology.

The Department is a constant source of inspiration through both formal (PhD guidance of core faculty, advisory, study boards, selection and assessment, faculty development programmes, continuing education) and informal (student project

guidance, guidance of young fellows, to many neighboring institutions, which have grown in stature over a period of a few decades (MSRIT, PESIT, and many newer colleges).

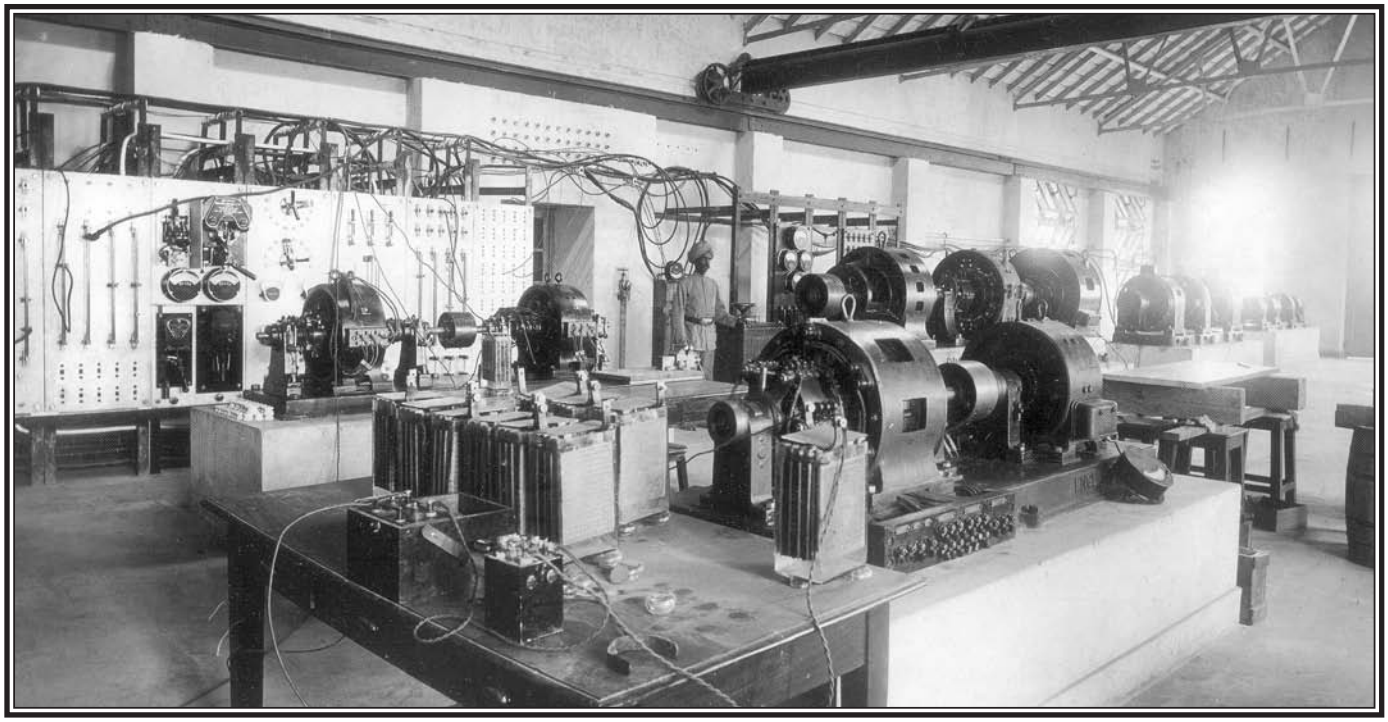
7. Alumni

The Department has imparted excellent training to more than 1500 engineers and scholars who have distinguished themselves as leading academicians, industry professionals, and entrepreneurs in several universities and industries in India and abroad. The talented alumni of the Department have gone on to become:

- Directors of National Labs such as NRSA, DRDO Labs (CAIR, SAG), and Chief Controller, R & D, DRDO
- Professors and Heads of Department in reputed universities abroad (about 25)
- Faculty in IITs, TIFR, and other reputed National Institutes (about 30)
- Founders of Companies such as Integra Micro, Ittiam, Strand Life Sciences, etc.
- Directors, Managing Directors, Top Executives, and highly successful technology leaders of companies such as Texas Instruments, HP, IBM India ResearchLabs, Wipro, Yahoo, GM ISL, Google, Amazon, Microsoft Research, etc.
- Editors of Prestigious International Journals

8. Summary

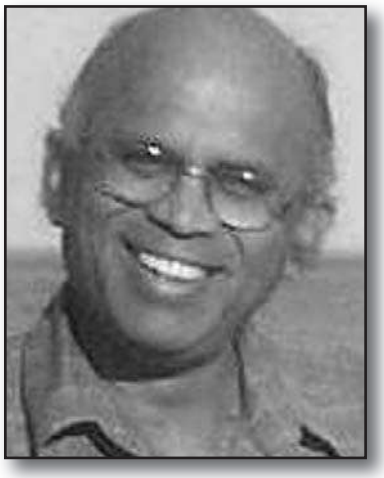
The Computer Science, System Science, and Information Technology group at the Indian Institute of Science has pioneered research, education, and development activities in India. The Department has maintained high standards of research and education over the last 35 years and can be truly proud of its accomplished faculty and brilliant alumni. In the years to come, the vision of the department is to be a leader in conceptualizing and realizing the promises of computer and information technology and to achieve a high quality research profile in the science and engineering of computing, information technology, and intelligent systems.



Inside an Electrical Technology Lab

Collecting Honey

By G Baskaran



***G Baskaran** had his basic education at Madurai and Ph.D. in Physics at IISc (1975-78). A distinguished Theoretical Physicist, he has made fundamental contributions to our understanding of a family of high temperature superconductors and strongly correlated electron systems, partly in collaboration with P.W. Anderson, a Nobelist from Princeton. Was deeply involved in shaping condensed matter physics activities at ICTP, Trieste, Italy for nearly 20 years. Was a Member at the Institute for Advanced Studies at Princeton.*

This article should be thought of as typical appreciation from the thousands of research scholars who passed through IISc. IISc is an oasis in the vast `academic desert' that India is. It is a bitter truth that in spite of having more than 300 universities, hundreds of Institutes and thousands of colleges in our country, the quality of life of a research scholar, lab facilities, infrastructure, quality of research, quantum of research, quality of professors, ability to contribute at the international level, leave much to be desired in the majority of places. From among the thousands of potential beneficiaries from our vast country, it is only a tiny percentage of fortunate ones like me who have had a chance to get trained at IISc with its excellent scientific, academic and social environment. On the occasion of the 100th anniversary of my alma mater I will recall some memories.

"Do you know Indian Institute of Science at Bangalore?" "No Sir!" "Well, ... it is a premier research institute in India. Don't lose your momentum, go there for research..." "I will try sir." This was a conversation with Dr. Richard P Riesz, one of my teachers, at the end of my first year of M.Sc. Physics, at the Madurai American College in the summer of 1969. That invaluable advice from a remarkable and friendly teacher was a turning point for me. I finished my Ph.D. at the Physics Department of IISc during 1970-75 and stayed on as an Institute Fellow till late 1978.

More than 30 years after my Ph.D., I continue my research career in the field called `condensed matter physics'. It used to be called solid state physics. In this article I will briefly recall how I got a solid foundation in this field in the most informal way possible at IISc. Thanks to various factors, I got an eclectic view of science. IISc introduced me to physics, biology and also the emerging science of complexity. During my stay at IISc, I was like a bee, jumping from flower to flower, enjoying and collecting honey. The nectar that I had collected during my 8 years of stay at IISc continues to nourish me. On the human side, it was a memorable stay as well.

I first joined the department of Applied Mathematics, when, Satish Dhavan, a dynamic and visionary director of IISc, was also an interim Chairman. A variety of applied mathematics problems were being tackled there. I tried my hands on surface plasma waves, under the supervision of Prof Chanchal Uberoi for nearly six months. It was a good training for me, but I found plasma physics tough and veiled.

Satish Dhavan helped my transfer to the Department of Physics, with Professor K P Sinha as my thesis supervisor. KP had just joined IISc, after a few years at Bell Telephone Laboratories. He brought with him his young collaborator Narendra Kumar. Kumar was perhaps the most dynamic Assistant Professor in the campus. Both KP and Kumar changed the scene in the department, by making student-teacher relation very informal and cordial. KP was very liberal and allowed me to grow and encouraged me to interact with a variety of people. The theory group at IISc consisted of only a handful of us research scholars, as there was no formal theory group before KP and Kumar joined.

What used to be primarily a spectroscopy department under the leadership of R S Krishnan, has changed its character and it had several dynamic groups: E S Rajagopal making measurements on critical exponents, phase transitions, R Srinivasan

and J Ramakrishna on NMR and NQR, P S Narayanan on ferroelectricity, Vishwamitra on biocrystallography, V S Venkatasubramanian on Mass Spectrometry, G Suryan on semiconductor physics, and a small theory group involving KP, Kumar and Som Krishan. Kumar and KP set up an excellent tradition over a decade and made it conducive for T V Ramakrishnan (thanks to efforts by Ramaseshan) to join the physics department and establish a vibrant theory group in the 80's.

I had excellent student colleagues: P Chandrasekhar, R Shankar, V M Nandakumar, Anil Kumar Abburi, V S S Shastry, Amritkar, Raj Lakshmi, Nandini, Nalini, Susheela, Ambadi Menon, Swaminathan, Ram Subramanian, Prasanna Kumar, Margaret Muthanna, Krishna Siddhantha and several others. Talking about physics and all kinds of things under the sun was a common thing. We had also postdoctoral fellows like P V Panat, G Ananthakrishna, Bani Krishnamurthy passing through the theory group. I had a brief overlap with H R Krishnamurthy, who had just joined as a young faculty.

Kumar was a lively physicist and a model teacher. He was more like a friend to us, taking us to cafeteria twice a day, all the while discussing exciting things in the forefront of physics. We used to go on weekend trips in his (Standard Herald?) car to beautiful spots in the neighborhood of Bangalore. His car was always packed with students. Kumar's courses and seminar talks were always inspiring and insightful. I still remember his vivid journal club talk on a Physical Review Letters article `Can a solid be a superfluid' by Anthony Legget. This was in 1971. I learned about the intricacies of non-classical moment of inertia and quantum coherence issues in supersolids from Kumar. It has helped me very recently, after nearly 36 years to write my own theory of supersolid He4, after this field got revived recently. One more high point was Kumar's regular summer visits to ICTP and bringing back information about new developments and stories about ICTP. So it was a dream for us to visit ICTP.

In the hostel (G Block) I had a neighbor and a friend, Joe Fernandez, a research scholar in the department of Aeronautical Engineering. He was working on flow past delta wings. We used to have hours of discussions on various fluid dynamics aspects of it. The end result was I took a fluid mechanics course from Prof Kuppu Rao in the engineering department. At that time I occasionally watched Srini (K R Sreenivasan, currently Director of Abdus Salam ICTP, Trieste, Italy) as a quiet and reserved research scholar in the aeronautics department. In the N-block hostel we had a large number of friendly folks in our corridor, including Gunupudi Subba Rao and Munishwar N Gupta. Actually Gupta introduced me to works of his hero, Szent-Georgi, a Nobel Laureate and discoverer of Vitamin C, and his far-sighted book `Electronic Biology and Cancer' (Marcel Dekker, NY 1979) on how quantum mechanical transport of electron in DNA could be playing key role in carcinogenesis.

Physics department at IISc had a good connection with, Raman Research Institute, Indian Academy of Sciences and National Aeronautical Laboratory and even some common programs, thanks to people like Prof S Ramaseshan. Good inter-institutional relations are very important for young people. It also brings a new synergy. I am happy that Bangalore continues to be so even now. It is in an environment like this I met three remarkable individuals, Subbiah Arunachalam, S K Rangarajan and Rajaram Nityananda. Actually, it was Arunachalam, a fellow Ph.D. student from IPC department, who introduced me to Rangarajan and Rajaram. Arunachalam was and continues to be a catalyst, a networker and doing good deeds without ever expecting rewards. S K Rangarajan was a Homi Bhabha Fellow at NAL. Rajaram was working at NAL as a Ph.D. student under the guidance of S Ramaseshan. After an year of stay at NAL, Rangarajan was directly inducted as a Senior Professor at the department of Inorganic and Physical Chemistry of IISc by Satish Dhavan.

Rangarajan (SKR) was an unusual theorist, a philosopher, a poet, a mathematician and also an electrochemist. More than all these he is a wonderful and warm human being, very sensitive to problems around us with profound insights, be it personal or social or political or literature or scientific. Rangarajan met us, students of theoretical physics, and advised us that learning concepts and techniques as deeply as possible (not for the sake of writing papers) through group discussion is an integral component of doing theoretical physics. He organized meetings twice a week at his house at Malleswaram in the evenings 8 to 11 pm. His wife was very kind to us and supplied us with tasty snacks. We became friends of Rangarajans and their five children.

.../contd. p43

IISc Global Conference Committee Members & Volunteers at Work!

IISc Global Conference Committee Members & Volunteers at Work!

It is in Rangarajan's house that we learned rather deeply the then fast developing renormalization group technique in statistical mechanics, Anderson localization problem, etc. Later I had long collaboration with SKR on many body quantum theory of electron transfer in electrochemical systems. Very often it was Rajaram who led the discussion and gave us deep insights and worked out the technical details. Rajaram was a Feynman follower and imbibed a characteristic clarity of presenting things, always going to the heart of the matter. I have not seen many in my research career who is that wide and deep in physics.

Rajaram taught me many things, in his regular visits (at least twice a week) to IISc from NAL. Actually he used to cycle 15 kilometers from NAL to IISc some times. (In the traffic congested modern Bangalore it will not be an enjoyable trip now). It was also the time when metal insulator transitions and Mott insulator were popular in IISc. A Jayaraman (Bell Telephone Laboratories) was spending a sabbatical at Bangalore (IISc-NAL) setting up a high pressure lab, to study metal insulator transitions in SmS and Ce. T G Ramesh, Ashoke Chatterjee and Rajaram were working on these problems. Kumar and KP were developing theories, involving Falicov Kimbal model. These and earlier expertise of KP and Kumar introduced me to Anderson's paper on superexchange mechanism, Jahn Teller effect, etc.

We had excellent visitors to the campus and I used to attend many of the lectures. We also had a memorable summer school organized by TIFR, some time around 1973. Michael Fisher gave us a set of wonderful lectures on renormalization group theory that was being developed by people like Kadanoff, Wilson and Fisher. Chandra Varma introduced us to valence fluctuation, heavy fermions and Hubbard model. It is in the summer school I met a fellow research scholar from TIFR, Sriram Shastry, and learned some aspects of spin-half Heisenberg antiferromagnet chains. I learned rudiments of homotophy theory for topological defects in condensed matter systems from some nice lectures by R Shankar (Yale) and about optical bistability from a lecture by T Venkatesan (Venky, Maryland).

We also had outstanding visitors like Michael Berry and Cohen Tanouji, who spent several weeks to several months. I was assigned the task of preparing lecture notes, in a 6 lecture course by Cohen Tanouji on dressed atom approach to interaction of radiation with matter. In the process I understood his lectures rather well. So even now I enjoy lectures on quantum optics, without much difficulty.

Discussion with Kumar and Rajaram's lectures at SKR's house made me deeply interested in the hard problem of Anderson localization. I was exposed to P W Anderson's work from several angles. Very soon I realized that Anderson is an important name and he became my hero. I organized regular journal club talks where we will present Anderson's most recent works. I remember Amritkar presenting Anderson Varma Halperin's two level system work in glass and my own 2 or 3 talks on Anderson-Edwards work on spin glasses, involving replica tricks. I was so obsessed with Anderson's work that once I had a dream. In my dream, I read, thoroughly enjoyed and understood a recent article by Anderson, only to wake up to find that I do not remember what the content of the paper was! Part of my dream has come true. Much later, thanks to my association with IISc, ICTP Trieste and Erio Tosatti, I actually ended up becoming a close and long time collaborator of P W Anderson, a Nobel Laureate from Princeton from the year 1984.

On another front, we had the beginning of the Center for Theoretical Studies (CTS) during my time at IISc. George Sudharsan was the Director of this Center. He shared his time between Texas and IISc. It had permanent physics faculty like N Mukunda and later R Rajaraman. Both were inspiring teachers. Mukunda taught me the elegance of mathematical physics and was a warm, supportive and conscientious teacher. Rajaraman gave me confidence and made quantum field theory friendly. A K Rajagopal was in the CTS faculty for a while. I benefited quite a bit by discussing with him. CTS had a variety of visitors from India and abroad. I used to interact with almost all young visitors and learn from them. People like Madav and Sulochana Gadgil, Sharatchandra were also active faculty of CTS.

Mukunda and Sudarshan organized an excellent school on Mathematical Biology at Bandipur in the Mudumalai region of the Western Ghats. It introduced me to some nice biology. One of the benefits of this summer school was a memorable 2 day (unprepared) hike through the elephant infested forests from Bandipur to the city of Ooty. My mates were Amritkar, Ajit Khembavi and Ranjit Nair (?). I cannot forget interesting incidents like hearing trumpeting elephants and later villagers

telling us how stupid we were in walking carelessly through the forest, the way we did!

It is at CTS that I met G Rajasekaran, a remarkable high energy theorist, who had given up a lucrative job at TIFR and decided to join the Department of Theoretical Physics at the University of Madras. It was Rajasekaran, who was partly responsible for my joining University of Madras after my stay at IISc and later at Matscience, after my stay at Princeton. CTS also introduced me to Vikram Soni and N D Haridass, who became close friends and colleagues later.

Neighboring Raman Research Institute also attracted excellent visitors. I also went there to collect my honey. I remember listening to Hanbury Brown, Bloembergen and several others there over years.

IISc library was very special for us. I religiously spent the entire morning of every Saturday reading and scanning through current journals. I believe, it is still one of the best and functional library in the country. I also saw Raman once in the library of IISc in the end of 1970, a couple of months before he passed away. One day, the calmness of IISc library of was broken by an old man making loud enquiries to one of the library staff. Annoyed, I turned around and saw Raman at a distance. Then I walked towards him, pretending to take a book, and had a closer look at the great man.

It is during my time that G N Ramachandran had moved to IISc from Chennai. He was a soul full of enthusiasm and energy for science in general. I was inspired by his performance in seminars. At that time he was straying into some formidable field involving mathematical logic, from molecular biology, in which he was a world leader. Some of my friends were his graduate students.

When CNR Rao had just joined as Professor at IISc, Ramaseshan once brought him to physics department and introduced me to him. As the senior most and very inquisitive condensed matter theory student, I had an interesting conversation with CNR Rao on the high spin low spin transition in lanthanum cobaltate. Exposure to superexchange, oxides and quantum magnetism at IISc actually prepared me for later collaborative works with Anderson. It was Ramaseshan who also put me in touch with one of the visitors Afza Begum, who became my collaborator.

I cannot forget the growth of Pramana, the famous Indian journal of physics from the Indian Academy of Sciences, Bangalore in my hostel room. It turned out that Arunachalam, even as he was a Ph.D. student in the IPC Department, was given the task by Ramaseshan of starting the journal Pramana, using his experience in editing CSIR journals at Delhi. Soon he quit his Ph.D. career and became a full time Indian Academy Staff and was my (unofficial) room mate in the N-Block hostel. So we used to edit articles, write to referees etc. Once I remember Arunachalam sending an article on plasma physics to the Nobel Laureate Alfven for refereeing and also getting a referee report. I believe that the momentum and standards that Arunachalam and Ramaseshan created continues even now.

I had seen at least half a dozen Nobel Laureates during my time at IISc. I have heard inspiring talks by Dorothy Hodgkin and Max Delbruk. One of the high points was my meeting with the two-time Noble Laureate John Bardeen. Being the senior most theory student I had to engage him for a while. It turned out to be more than an hour's discussion on some problems I was working on a model for charge density waves. I was so pleased, as a graduate student, Bardeen listening to me and making very useful suggestions about the relevance of my model. Later I met Bardeen in 1987 at Urbana Champaign, where he listened to my colloquium on RVB theory of high temperature superconductivity and also had an hour long discussion with him.

I had a good dose of applied mathematics at IISc, a full non-linear analysis course offered by Ananth at Electrical Engineering department, probability theory course by Krishna Athreya, integral equations by Vittal Rao, Witham's excellent course on non linear waves, etc.

The relations with fellow research scholars were very cordial and happy one. I continue to be in touch with some of them. I had friends from all over the campus. My friend Hothiappan, a shy fellow from the hills of Ooty, used to ask me, `Is there

any one at IISc who is not your `hello' friend?' It was a friendship culture propagated by people like Aeronautics Ramani and Civil Engineering Pandian. Hostel and Gymkhana were great place to nurture our friendship. I had eaten in all the messes (eating place) - A, B, C and NV (non-vegetarian). The messes were so special that many of our friends were regularly eating in mess as our guests, even after they left IISc.

Another memorable incident for me was receiving two prizes (the only prize for sport activity that I ever got), from the hands of Usha (Mrs N Mukunda), a famous table tennis star of India. Actually I had gone to watch the gymnastics competition in the IISc Gymkhana and had no intention of participating in it. On watching the performance I realized that I could do better (thanks to my early training in the George Joseph Poonga, a public park at Madurai) and joined the competition and got first prize in Roman rings and rope climbing.

We had special friends, like Rangarajans, Kumars, Arunachalam, Pandian, Porkodi, Glory, Suryanarayanan, Menon, Nalini, Nandini, Anil Kumar Abburi, Anil Junior, Swaminathan and others, who became family friends, after I got married in 1975 to White Rose. Later we moved to the IISc married students hostel. It was in 1976 that our son Satish was born and he provided an additional attraction for our friends to come to our house in the evenings. I still remember the affection and warmth with which Kumar announced the birth of our son Satish in a department function. When I first moved to Bangalore with the young bride, Rangarajans played the role of parents and got us all basic utensils to set up a family kitchen at the nice house in Sadasiva Nagar, where we had the good company and affection of Suri and Jayachandran family.

I cannot also forget a key role that my marriage played in getting my Ph.D. It was well known that I was jumping from problem to problem and my Ph.D. supervisors and well wishers had constant worry whether I will ever submit my Ph.D. thesis. The news from my parents of my impending marriage did the trick. I decided to submit my thesis first, before I submitted myself to my wife.

The neighborhood of IISc offered very nice areas for long walks. In those days, just behind the IISc campus, we had farming villages with village belles taking water in the village wells, etc. Several hours of aimless walk for several miles in the afternoon of Saturday, through the busy Bangalore city was a routine that I enjoyed very much.

Thanks to help from Arunachalam, I got travel fellowship to participate in a 1976 Winter school at the International Center for Theoretical Physics, Trieste, Italy, a great place for theoretical physics founded and nurtured by late Professor Abdus Salam. That visit, as a young Ph.D. scholar from IISc, also marked a turning point in my professional career.

All the memories of my stay at IISc are actually sweet. It was honey moon in my scientific career.

It gives me great pleasure to congratulate the founders, nourishers, well-wishers, directors, teachers, students, workers, who have served over one century and made our dear `Tata Institute' a wonderful Institute. My wish is that for a country as large as India with more than a billion people, there should be more than 100 IISc's, or the existing universities should metamorphose into IISc's.

IISc Alumni Association of North America

Thanks

Science, Technology and Science Education: *Possible Insights for India from the U.S.*

By Rustom Roy

Rustum Roy, *is a citizen-scientist. He currently holds five professorships, three at Penn State and one each at Arizona State and U.Arizona. The first Indian ever elected to the U.S. National Academy of Engineering, he has also been elected to the National Academies of Science/Engineering in Sweden, Japan, India and Russia. He is nationally recognized in Science Policy, in Science-education and general-education, specifically in Science-Technology-and-Society, and in national religious-action fields.*

The steady flow of the last few months of guest editorials, letters to the Editor, articles in scientific journals, on the congeries of key words all appearing in my title has triggered this article. Many of these editorials and letters are by distinguished experts in India with vastly more intimate knowledge than I have. But they deal with the details, and incremental changes in substance and policy. I paint for this IISc event with a broader brush.

I write as a senior U.S. scientist, known as one of the very few also heavily involved in technology, science policy and science education. Albeit I have been an expatriate for nearly 60 years, I have remained keenly interested and tried to keep up on Indian affairs in these areas. I was the first Indian elected to the U.S. National Academy of Engineering and the cognate academies of Sweden and Japan. I have been deeply involved in the U.S. and international S/T policies at Federal and State levels, and have participated occasionally in developments in Indian S/T policies. In the 1950s and 1960s I testified before the Sarkar Commission, I went to see Pandit Nehru with K.S. Krishnan, to try to get ONR money for Indian institutions. Even before that I met with Panditji to discuss alternative strategies to stop the brain drain. I was, on various occasions, called in to Washington by a succession of Indian Ambassadors to the U.S. to attempt to facilitate possible sci-and-tech interaction and transfer between the two countries. These efforts were tiny, sporadic and with minimal effect. I list them only to illustrate my long-lived interest in the Indian connection within this area.

I write from the conviction that the S & T dominated world faces a major crisis because no country, no culture, has been able to "control" or "integrate" or "manage" the cultural dilemmas caused by an uncontrolled **technological** explosion. Indeed while the great French scholar, Jacques Ellul, completely grasped the problem in 1954 in his classic work, "The Technological Society," I had often suggested to him that perhaps we shared (not in public) the view that the situation may turn out to be something very clearly embodied in the quintessentially Indian metaphor of the Jagannath, or juggernaut. It is perhaps only the dream by an Indian, that the land of his birth may be endowed by its history and culture to contribute—nay, manifest a solution to the impending Armageddon-like clash of cultures: the Culture of Tradition (several different religions in different areas) versus the new 2-ton gorilla now roaming the vicinity, the Culture of Technology and Science. That is the challenge described, and the vision hoped for, in this paper.

An aside on language: The science-community — I include, I believe, most of the readers of, and writers in this issue — may not be sufficiently aware of the absolute necessity **NOT** to conflate or use interchangeably the terms "science," "technology," and "engineering;" nor the terms "culture," "religion," "theology." In the West a great debate rages today, (largely ignored in China and India, but nascent now in Islamic countries) under the banner of "Science and Religion." I have written extensively on the gross linguistic muddle in these discussions. [1, 2] I merely point out here that the proper mathematical relationship among these terms can be best expressed as:

Technology: Religion: Science: Theology.

Discussions on "Science and Religion" pair incommensurable quantities, and are rendered much less useful than they could be. To illustrate some of these interactions I choose some examples from different areas of S/T activity.

Science Education

Let me start with science education in which I — even as a Research Director of the nation's largest academic materials enterprise — have been actively working for 30 years. As a matter of historical fact India has benefited fabulously from the fact of the large (albeit arguably of not fully acceptable quality) machinery already in place for training **large numbers of India's citizens** in mathematics, physics, chemistry and biology, **in English**. India's dramatic position in IT, is in no small measure due to **mass training**, up to modest levels, in S/T in English. There is in India, albeit much worse in the U.S. and Europe, a great anxiety about the science literacy of the general student and the quality of the future research scientists. Let me start by showing how badly informed much of this concern is, and how misplaced is the blame put especially by science-research leaders who are innocent of familiarity with the **realities** of how most humans learn of science/technology, **especially in the blaming of teachers.**

I start by recounting the data from an extensive research project sponsored by the Annenberg Foundation within the last several years. The researchers studied the science "literacy" of a sample of the **graduates** of Harvard and MIT. The researchers chose to see how many of these **graduates** of two leading S/T institutions of the U.S. remembered some of the most basic of "science" **concepts** taught to them often in the very best colleges and high schools of the nation. At the annual graduation ceremony, each graduate (or faculty member) was asked these questions:

1) Why do we have winter and summer on earth?
2) From where does the mass of a large tree come from?
3) Can you light the bulb given to you, using the battery and the piece of copper wire given to you?

Now recall that these students are from every discipline of these two great schools—including physics and chemical engineering majors. Over 90% of the students gave as the reason for winter and summers as: "The sun comes closer to the earth in the summer, and further away in the winter." The same percentage gave wild guesses and failed to even mention the word "photosynthesis" in the tree question. And again the same percentage failed to touch the copper wire to the base of a battery and the side of the bulb. Now, anyone advocating some new science education strategy must go ahead and explain this staggering disconnect of science from practical reality in these students, educated at the best Universities, many majoring in science/ engineering. It is vastly more impressive to view this evidence in a short video clip. (Available at http://www.learner.org/resources/series28.html by clicking on the VoD symbol in the lower right corner). **Now that is obviously a universal failure of the education of citizens, in science.** What can be wrong here? Are we teaching the wrong "Science"? Yes, indeed we have absolutely confused the science needed by the "average citizen" with that for the "best scientist."

As a schoolboy in St. Paul's, Darjeeling in 1939 I won the Majumdar Science Prize and received a copy of the book "Science for the Citizen" by Lancelot-Hogben. The science community's **FIRST** responsibility is the teaching of **Science for the Citizen.** If we do that well, I am sure that the natural selection by aptitude, not I.Q., but A.R.Q. (abstract reasoning quotient) will select out a sufficient fraction of scientists, and a fraction with good grades in Inductive Reasoning from Concrete Reality, will populate our engineering schools. **But we must care about citizens first**, because they become the P.M.'s and CEO's, not only engineers or scientists.

What is wrong in the suddenly fashionable push for getting University researchers — rank amateurs — to **teach** better science in K-12? They include the absurd attempts by many of my U.S. colleagues, to attract youngsters into science by showing them high tech examples of nano science, HRTEM photos, or the latest pictures from the Hubble. This is reductionism carried to a reductio ad adsurdum. The student supposedly will understand steel and cement better by looking at the millionth picture of a carbon nanotube?? Which is of greater permanent value? Which is she likely to see again and again? Cement or nanotubes. Science cannot be 'sold' by the same tools as entertainment advertising — jazziness. Science

involvement is a **contact sport**. **Touch** is the human's first sense, learned in the womb. Touch-science; hands-on experimentation and play, and repeated exposure are vastly more important if you want to expand the pool of S/T literate citizens, and gain a solid S/T workforce.

What is Science?

I have space for only two more areas of controversy. That is, the subtle change in the self-understanding of "science" by scientists. Two easily observed changes concern me deeply. First, the increasing drift away from the supremacy of data and facts and experiments, to explanations and theories, and models. If you don't have a theory to explain it, it can't be true? Or at least it should **not** be published!! The reaction of many scientists presented with some really new, very surprising new data, or facts, is astounding. It is often: Not 'Isn't that amazing! If true it would be very intriguing and possibly valuable." It is instead: "But can she/he explain it? If not, is it really worth anything?" This absolute absurdity of requiring a "theory" to challenge an experimental fact is the undoing of science. After all, **theories** come and go; solid facts remain forever. At Penn State in the period 1946–60, I observed the 100% opposition by the American Geoscience establishment to Wegener's observations and proposal for the idea of Continental Drift. This gross national error was only slowly beaten into submission in some 10–15 years. When my graduate student, Frank Dachille, with a degree in chemical engineering proposed in his amateurish 1953 book, "Target Earth,"[3] that the pock-marking on the moon was due to meteorite impact, I was told by the President of the Geological Society that he should be dismissed as a Penn State grad student (albeit he was working on phase equilibria at 100 kbars!!) for holding such absurd opinions. Meteorite impact on the moon (and earth and Mars in a few years) went on to provide decades of employment for the very same critics!!

My point? We must restore the absolute primacy of **experimentation**, of **facts** and **data** in science. Theory alone must be carefully evaluated for value. To agencies I say: Demand rigorous experimental verification. Only support theoretical work if it is coupled to a partner who can do experiments to check the theories.

Science Policy

I turn next to a worldwide **science policy**[1] issue: How much of **public** funds should be allocated to **esoteric a-telestic** (without social purpose) science and how much to applications-driven basic sciences (the key criterion at Bell Labs for 50 years), which Penn State's MRL took as its own — on the way to being recognized as the #1 MRL in the World by ISI, in terms of the number of highly cited scientists.[4]

What really is the justification for spending fantastic sums of **public money** for esoteric science on new particles, or galaxies, with no possible benefit to the citizens (who, please recall, think the sun comes closer to the earth in the summer!). I served four Governors of Pennsylvania as part of the Science Advisory apparatus: Our rough guideline was: **public funds for public good**: Let Bill Gates and Paul Allen fund exotic science like Life on other Planets — and they do. As a rare opponent to funding any — especially such — "Big science," I became, by default, the senior-most scientist opposed publicly, systematically and actively to the Superconducting Super Collider (SSC) funding. After several years, we succeeded in stopping the allocation of an estimated $35 billion lifetime cost to such a project. This was a major signal to the science community. Of course it did not help me with the agencies (and colleagues) involved!! But American science and its physics have continued to thrive. The facts are on my side. Most of the world's really great scientific advances were made on the 'sealing wax and string' model. No Federal Agencies, no time-wasting proposals, no ludicrously **mis-named** "peer"-review process, helped Einstein, Born, Heisenberg or Fleming, not to mention Newton and Faraday, in producing the greatest scientific revolutions.

Hence key macro-science public policy issue #1 is the ratio of purpose-driven to non purpose-driven science. This is not how **much** non-public purpose related science should any **scientist** personally do — every scientist should be free to approach any problem, but the issue is: How much of a nation's **public resources** can be taken from road building or feeding the poor, to fund research which perhaps a **maximum** of 100-1000 other scientists will **ever read or understand**, and which is of no

value to the citizens who pay for it. One needs for any country's leaders: "Criteria for Scientific Choice" as Alvin Weinberg founder and first Director of OAK RIDGE titled his papers, to which I refer the reader for useful guidelines.

References

1. R. Roy, D. Shapley, "Lost at the Frontier—U.S. Science and Technology Policy Adrift" (with Deborah Shapley), Philadelphia: ISI Press, 223 pp. (1984)
2. "Religion/Technology, not Theology/Science, as the defining dichotomy," **Zygon** 37(3): 667-676 (September 2002)
3. Kelly, Allan O. and Dachille, Frank. Target: earth: the role of large meteors in earth science, Pensacola Engraving Co., Pensacola, Florida, 1953.
4. "Materials Science: A Few Institutions Lead the Way, Highlycited@Thompson.com, April 2003. http://isihighlycited.com/isi_copy/Comm_news27.htm

IISc Council in 1914

First Director, English Chemist Morris Travers (Third from Left in Front Row)

IISc Reminisces

By Ashok Sinha

***Ashok Sinha** earned his B. E. in Metallurgy from IISc and a D. Phil from Oxford University. He has contributed to solid state physics at Cal Tech, to semiconductor process technologies at Bell Labs, and in semiconductor process equipment business at Applied Materials, from where he retired as a Senior Vice President in 2006. He is a Fellow of the IEEE. He received the Institute's Alumni medal in 1965 and the Distinguished Alumni award for 2005. He has served as a board member on several companies, including The Tech Museum of Innovation in San Jose, CA.*

I arrived at the Institute in 1962, following an eventful childhood observing my Father fight coal mining safety issues. This was followed by a short, but value-setting schooling at Vikas Vidyalaya, Ranchi, and a rather chaotic, but successful undergraduate stint at Patna University.

The Institute turned out to be a kind of blissful Shangri-La. First, the weather and the clean Bangalore city with its many cinema halls appeared to be a pleasant change. The student body, from all parts of India, seemed so distinguished and bright. Third, the organized culture and physical facilities set the stage for focus on the well-taught multitude of courses, with an efficiency and clarity that I marvel at, even to this day. Needless to say, I thrived. My favorite teachers, among many, included my mentor, Dr. KP Abraham, who gently guided me through not only metallurgical thermodynamics, but also the processes of technical literature search, a seminar presentation entitled "Metallography at Atomic Level", and applications to continue studies at Universities in the UK and USA.

In December 1963, well before my planned graduation in 1964, came a welcome telegram from Professor Hume-Rothery accepting me for a D. Phil. bursary at Oxford. I was happy to accept, with gratitude. Ironically, a rather generous acceptance letter arrived later from MIT Nuclear Engineering, my first choice. I had to regretfully decline, thanks to strong advice from my Father. In retrospect, this has turned out to be a wise decision. I successfully took the D. Phil. degree in summer 1966, at the ripe young age of 22. The main lesson learnt during those short formative years – the secret is in learning how to learn, with curiosity and enjoyment, and no fear of failure.

Dr. Abraham also advised me to learn the intellectual foundations of the Hindu culture, which led me to read my first English version of the Bhagwad Gita by Radhakrishnan. Sure enough, soon after arriving at Oxford, Maureen Christian, the wife of Dr. J W Christian invited me to talk on this topic to her class. Thanks to the homework, I apparently did a reasonable job interpreting, through an example of the Bridge game, basic differentiating concepts of Hindu culture such as the lack of "original sin" and one's personal responsibility to skillfully exercise the universal gift of "free will".

Continuing on, two of many memorable alumni I met were Dr. Ranganathan, at Cambridge during my first week in England, and Professor Anantharaman, who had earlier graduated from Oxford. Another notable meeting occurred with Director Satish Dhawan in Caltech. He kindly offered me a position at the Institute, but I had decided to go to Bell Laboratories for a career in semiconductor technologies. In 2003, I proudly showed off the Institute to Jim Morgan – Chairman of Applied Materials. Earlier this year, I received a most pleasant surprise e-mail from Professor Mohan informing me of recognition as a Distinguished Alumni of the Institute. This was a humbling honor, yet another testimonial to the warm ties that bind us, for a lifetime.

IISc Alumni Association of North America

Thanks

India's Space Saga

By Biman Basu

A retired scientist of the Council of Scientific and Industrial Research, ***Biman Basu*** *is a former Editor of the popular science monthly Science Reporter. He has been a regular broadcaster over All India Radio, has scripted several TV documentaries, and published more than 600 articles in various publications. He has 27 popular science books to his credit. He is a winner of the 1994 NCSTC National Award for Science Popularisation.*

After more than four decades of building and launching satellites in near-Earth and geostationary orbits, India's space scientists are now preparing for a big leap forward – an unmanned mission to the Moon. If everything goes as per schedule the first Indian space robot may land on the Moon by the end of the year. The two-year mission is also to carry out a survey of the distribution of various minerals and chemical elements on the Moon. With *Chandrayaan-1* India will complete an eventful journey that began on a modest scale on the shores of Kerala more than four decades ago.

The Indian space saga began just about 45 years ago, soon after the first man-made satellite Sputnik was put into orbit in 1957 by the erstwhile Soviet Union. India's planners didn't lose any time in chalking out a time-bound programme to reap the benefits of the newly emerging technology. At that time many had questioned the rationality of a poor country investing so much money in space research. But the pioneer of space research in India, Dr. Vikram Sarabhai had a clear vision; he was convinced that space technology offered the only solution to many of the nagging problems that plagued a vast and economically backward country like India. He would say, "It is not the question of whether India can afford to invest in space research, but whether she can afford not to invest in it." Thanks to his foresight, India today ranks among the handful of space-faring nations of the world.

Apart from Vikram Sarabhai there were several others who contributed significantly to the growth of India's space capability. Notable among them were Satish Dhawan, Vasant Gowariker, K. Kasturirangan, A.P.J. Abdul Kalam, Brahm Prakash, E.V. Chitnis, A.E. Muthunayagam, R. Aravamudan, Pramod Kale, and G. Madhavan Nair. It was their dedication and zeal that helped overcome every hurdle and carry on despite sanctions, occasional failures and setbacks.

A significant feature of the Indian space programme has been the emphasis on reaping the benefits of space technology in the shortest possible time. So it was decided to go ahead simultaneously with activities in all the three areas related to space technology, namely, rocket development, development of satellites, and also gain experience in development of the infrastructure for fruitful application of space technology. Consequently Indian Space Research Organisation (ISRO) took up development of satellite technology even before it could build rockets to launch them and carried out television broadcast using satellite even before it built its first communication satellite. The logic was simple; there was no point in wasting time by waiting till an indigenous satellite was available or the launch capability was attained, which, in any case, would take several years. The experience of the past 32 years, since the first Indian-built satellite Aryabhata was put into orbit by a Soviet rocket in 1975, have demonstrated the prudence of such a policy. The success of India's nine remote sensing satellites of the IRS series and the satellites of the INSAT 2, 3 and 4 series, and the widespread use of satellite-based services are good indicators of the success of this policy.

Timeline

1962	Indian National Committee for Space Research (INCOSPAR) formed by the Department of Atomic Energy and work on establishing Thumba Equatorial Rocket Launching Station (TERLS) started.

1963	First sounding rocket launched from TERLS (November 21).
1965	Space Science & Technology Centre (SSTC) established in Thumba.
1969	Indian Space Research Organisation (ISRO) formed under Department of Atomic Energy (August 15).
1972	Space Commission and Department of Space set up (June 1). ISRO brought under DOS.
1975	First Indian Satellite, *Aryabhata*, launched (April 19).
1975-76	Satellite Instructional Television Experiment (SITE) conducted.
1977	Satellite Telecommunication Experiments Project (STEP) carried out.
1979	- *Bhaskara-I*, an experimental satellite for earth observations, launched from Soviet Union (June 7). - First experimental launch of SLV-3 with *Rohini* satellite on board (August 10). Satellite could not be placed in orbit.
1980	Second Experimental launch of SLV-3, *Rohini* satellite successfully placed in orbit (July 18).
1981	- First developmental launch of SLV-3. *RS-D1* placed in orbit (May 31). - *APPLE*, an experimental geo-stationary communication satellite successfully launched (June 19). - Second Experimental launch of SLV-3, *Rohini* satellite successfully placed in orbit. (July 18). - *Bhaskara-II* launched (November 20).
1982	- *INSAT-1A* launched (April 10). Deactivated on September 6.
1983	- Second developmental launch of SLV-3. *RS-D2* placed in orbit (April 17). - *INSAT-1B* launched (August 30).
1984	Sq. Ldr. Rakesh Sharma becomes the first Indian to go into space as part of an Indo-Soviet manned space mission (April).
1987	- First developmental launch of ASLV with *SROSS-1* satellite on board (March 24). Satellite could not be placed in orbit.
1988	- Launch of first operational Indian Remote Sensing Satellite, *IRS-1A* (March 17). - Second developmental launch of ASLV with SROSS-2 on board (July 13). Satellite could not be placed in orbit. - *INSAT-1C* launched (July 21). Abandoned in November 1989.
1990	- *INSAT-1D* launched (June 12).
1991	- Second operational remote sensing satellite, *IRS-1B*, launched (August 29).
1992	- Third developmental launch of ASLV with *SROSS-C* on board (May 20). Satellite placed in orbit. - *INSAT-2A*, the first satellite of the indigenously built second-generation INSAT series, launched (July 10).
1993	- *INSAT-2B*, the second satellite in the INSAT-2 series, launched (July 23). - First developmental launch of PSLV with *IRS-1E* on board (September 20). Satellite could not be placed in orbit.
1994	- Fourth developmental launch of ASLV with *SROSS-C2* on board (May 4). Satellite placed in orbit. - Second developmental launch of PSLV with *IRS-P2* on board (October 15). Satellite successfully placed in polar sun-synchronous orbit.
1995	- *INSAT-2C*, the third satellite in the INSAT-2 series, launched (December 7). - Launch of third operational Indian remote sensing satellite, *IRS-1C* (December 28).
1996	- Third developmental launch of PSLV with *IRS-P3* on board (March 21). Satellite placed in polar sun-synchronous orbit.
1997	- *INSAT-2D*, fourth satellite in the INSAT series, launched (June 4). Becomes inoperable on October 4. - First operational launch of PSLV with *IRS-1D* on board (September 29). Satellite placed in orbit.
1999	- *INSAT-2E*, the last satellite in the multipurpose INSAT-2 series, launched by Ariane from Kourou French Guyana, (April 3). - Indian remote sensing satellite, *IRS-P4 (OCEANSAT)*, launched by Polar Satellite Launch Vehicle (PSLV-C2) along with Korean KITSAT-3 and German DLR-TUBSAT from Sriharikota (May 26).
2000	- INSAT-3B, the first satellite in the third generation INSAT-3 series, launched by Ariane from Kourou French Guyana, (March 22).

2001 - The first developmental launch of GSLV-D1 with *GSAT-1* on board from Sriharikota (April 18). Placed the satellite in a lower orbit.
- ISRO's Polar Satellite Launch Vehicle, PSLV-C3, successfully launched three satellites – *Technology Experiment Satellite (TES)* of ISRO, *BIRD* of Germany and *PROBA* of Belgium – into their intended orbits (October 22).

2002 - Successful launch of *INSAT-3C* by Ariane from Kourou French Guyana, (January 24).
- ISRO's Polar Satellite Launch Vehicle, PSLV-C4, successfully launched *KALPANA-1* satellite from Sriharikota (September 12).

2003 - Successful launch of *INSAT-3A* by Ariane from Kourou French Guyana (April 10).
- The second developmental launch of GSLV-D2 with *GSAT-2* on board from Sriharikota (May 8).
- Successful launch of *INSAT-3E* by Ariane from Kourou French Guyana (September 28).
- ISRO's Polar Satellite Launch Vehicle, PSLV-C5, successfully launched *RESOURCESAT-1 (IRS-P6)* satellite from Sriharikota (October 17).

2004 - The first operational flight of GSLV (GSLV-F01) successfully launched *EDUSAT* from Satish Dhawan Space Centre SHAR, Sriharikota (September 20).

2005 - ISRO's Polar Satellite Launch Vehicle, PSLV-C6, successfully launched *CARTOSAT-1* and *HAMSAT* satellites from Sriharikota (May 5).
- Successful launch of *INSAT-4A* by Ariane from Kourou French Guyana, (December 22)

2006 The second operational flight of GSLV (GSLV-F02) was unsuccessful (10 July). Both the rocket and the communications satellite *INSAT-4C* had to be destroyed over the Bay of Bengal after the rocket's trajectory veered outside of permitted limits.

2007 - Successful launch of *INSAT-4B* by Ariane from Kourou, French Guyana (12 March).
- ISRO's Polar Satellite Launch Vehicle, PSLV-C8, successfully launched Italian astronomical satellite,

Sarabhai's Vision

Vikram Sarabhai came from a wealthy family of industrialists, but he chose a career in science. He presented his first scientific paper before a scientific audience at the Indian Institute of Science (IISc), Bangalore, in 1941 when he was scarcely 21 years old. Although Sarabhai returned to Cambridge after the War, the years at IISc, especially his interaction with C.V. Raman, left an indelible mark on him. Raman believed that in order to make a mark in science, Indians needed to take advantage of the unique opportunities available within the country. Later, when Sarabhai established a sounding rocket launching station and identified applications for India's space programme, his reasoning reflected this line of thought. Sarabhai's dream would lead to the creation of a full-fledged space programme that would ultimately make India one of the leading space-faring nations.

- Adapted from: ***Reach for the Stars*** *by Gopal Raj, (Viking, Penguin India, 2000).*

On Myself and IISc's Hundred Years…

By Prof. H S Mukunda

***Prof. Mukunda**, former Professor in the Aerospace Department, Indian Institute of Science has made contributions in Combustion, Rocket Propulsion, Biomass gasification Technology and Gasification based biomass Stoves. A Fellow of Indian Academy of Sciences, Indian Academy of Engineering and Aeronautical Society of India, he is a recipient of several awards which includes Om Prakash Bhasin award, DRDO award, Distinguished Alumnus award of IISc, Sir M. Visweswariah award from Karnataka Government.*

My first encounter with IISc was some time in December 1962, a year before my graduation, at which time I was at Bangalore for laboratory work in Mechanical Engineering (my college, National Institute of Engineering, Mysore, had not acquired these facilities yet). A friend of mine brought me to the Institute to meet up with his relative in Aeronautical Engineering. I was amazed and pleased to see select group of people working till later part of the day well into the night even though the rest of the place was locked up and looked deserted. Having had some bad experience during industrial training in the railway workshop at Mysore, I had "decided", I would never join an industry demanding fixed timings (!) and would only join a place that allowed freedom to work away as much as needed any time desired. I simply fell in love with the Institute and I intended pursuing M E here almost instinctively. The only place I applied for was Institute with Aeronautical Engineering as the first option (In retrospect, I have often wondered about this foolish bravado for not applying to any other place). It turned out that I got direct admission (admission based on past performance – within the first three ranks in the examinations) without an interview. I have again wondered whether I would have been accepted at all if I have had to face an interview committee. I joined the Institute for M. E. in 1963. Finishing up the masters in 1965 pursued Ph. D with Prof. V. K Jain and Prof S. Dhawan as the supervisors and finished it in 1970. Joining as a lecturer in 1969 in an opportunity that got created due to demand of faculty in newer areas to cope with the new defence sponsored program on rockets and missiles, I continued till retirement at the Institute except for a two year stint at NASA Langley Research Center at Hampton, Virginia in USA and several brief visits to other countries for conferences or as a part of some delegation. It is true to say that I enjoyed the stay both as a student and as a faculty member. There were many difficult times, but I recollect no period when freedom to do what I really wanted was curtailed.

During the time I was pursuing my Ph. D., the department had a fair complement of excellent research students and particularly in fluid flows. Most of them were students of Prof. R Narasimha, Prof. M A Badrinarayan and Prof S. Dhawan. All of them were very active and my most enjoyable moments would be when we got together and talked about science, India and its problems and almost anything under the sun very intensely. Amongst the students Dr. T. S. Prahlad and Dr. S. Vasantha went on to become directors of NAL, CSIR and SHAR centre, ISRO respectively. Others became faculty at IISc and as expected, everybody worked through at IISc till retirement.

The area of combustion or reacting flows was very new in the department. The learning of the subject was largely by intense self-reading and discussions with co-students. This self-learning that got imposed on us proved to be of great benefit in the long run since thinking through intricate new issues could be accomplished with much less external input **bringing greater confidence of other academics and industries in one-self.** Aeronautics in the sixties and the seventies appeared dismal with no development projects being taken up and a large number of paper exercises on the design of fighters being carried out with the Government or Air force supposedly stating that since HAL had no experience in advanced technology it would be difficult to support such a project. This got repeated several times and the joke was that every head of HAL who happened to be a senior person from air force took such a position to enable him to buy nice equipment from overseas and a better prospect for himself (to become the next air chief). It was clear if we have to be intellectually alive and be relevant (particularly so in Engineering) that I suppose is the aspiration of any academic, we had to think of strategies of achieving this objective.

It was also a peculiar period when Ph. D from abroad (that meant usually, USA) was thought superior to Ph. D from India. Also no visionary outlook seemed available from the near surroundings. I remember one event of this period of despondency. I had been working on a set of ideas on a class of propulsion systems called hybrid rockets that appeared very relevant to India as it was a high performing but robust and a very low cost system. To a few friends, I stated somewhat wistfully, can we not do something to such progress in some special area unique to us (but relevant to others) that demands that scientists from overseas come and learn here much like it happened in the past at Nalanda and Takshashila. A few colleagues around me looked at me peculiarly and brought me back to reality. As it turned out, of the two major activities that I was instrumental in initiating, the subject of hybrid rockets did not attract the appropriate agency subsequent to ten years of effort resulting in several publications, Ph. D for a student and occasional sporadic interest by several other agencies, but the subject of thermal conversion of solid fuels, particularly biomass has resulted in a situation that was reminiscent of Nalanda.

At the court meeting of the institute that happens in the month of March annually, there is a court lunch followed by the meeting. In the year 1981, at such a lunch, I was met by a senior colleague, Prof. Amulya K. N. Reddy who was leading a center for the Application of Science and Technology for Rural Applications (ASTRA) and asked if I could look at a technology called "gasification of solid fuels" by which process it was possible to run diesel engines to generate electricity. His idea was that India had about 3 million diesel engine pumpsets for water lifting and it would be desirable to replace as much diesel as possible by using the gasifiers. His outlook was that this would make a tremendous difference to the oil import and make the rural operations less dependent on diesel with a continuing upward trend in its price. Impressed with these thoughts, I discussed the subject with Dr. U Shrinivasa (who subsequently chose to look at biodiesel seriously at the Department of Mechanical Engineering) and we started working on the subject with a grant from the Karnataka State Council for Science and Technology (KSCST). By this time I had a reasonable understanding of the field of combustion, but mostly of liquid and gaseous fuels but very little of solid fuels. I thought through for myself that as an "expert" in combustion if I was posed questions of biomass would burn and could I estimate the rate of combustion, etc, was I in a position to deal with the issues confidently. I came to a conclusion that it was clearly "No", was ashamed of myself that I knew little on a subject so much more native than what I had looked till then.

The next five years saw serious research and development to understand the earlier work and complement it with the needed work to enable design of combustion systems as well as gasification systems. More arguments were found to say why gasification of solid fuels allows better control on combustion, emissions, and ability to produce the starting "stuff" for chemicals including bio-fuels. Systems for power levels of 5 to 100 kWe were designed, produced using a local support fabrication facility and tried out in the field under a program of the Ministry of non-conventional energy sources. One of the early milestones were reviewed by a committee chaired by Prof. Dhawan after he had retired from IISc, vigorous and as clear cut as he was when he was the director. The next ten years saw an enormous consolidation of the efforts in terms of internationalizing the knowledge base. Three international training programs were conducted. These were attended by scientists from a dozen countries both east and west. Half a dozen students came from overseas to spend months for familiarization, training and research studies. Technologies were transferred to eight licensees in India and two overseas. Engine companies like Cummins have collaborated and have for the first time in the history of gasification in the world agreed to produce and market producer gas based engines for power generation. More than fifty gasification systems with thirty five of them for electricity generation have been built. Systems of 1 MWe have been built and are operating commercially for more than three years. Every year, nearly a hundred people – a farmer to a CEO of a multi-national company visit the laboratory seeking information, knowledge, cooperative study and some, technology. There is an outstanding team of academics and researchers currently active in the field at the combustion, gasification and propulsion laboratory in the department dealing with basic research and development, solving field related problems, providing advice on new concepts of bio-residue use in electricity generation process for a rural community or an industry and of course, creating project profiles on techno-economically meaningful basis. The management is structured to operate under a society called "Advanced Bio-residue Energy Technology Society" (ABETS) whose board chairman is the director of the Institute. Research and Development are continuing with vigour even in 2007. An effort in the last three years has led to modern gasification based cook stoves and combustion devices. Fans that are built for computers (and so of low cost) are used in carefully thought-out fluid dynamically driven designs to burn solid fuels in an efficient and environmentally benign manner. These technologies

have been transferred to a multinational (BP, India) who are intending to commercially exploit it to service a huge rural market in India and other developing countries. Protecting the technology requires patenting in India and select countries (where it is perceived that the technology uptake may take place) to enable reduction in investments for maintaining the patents. The area of IPR is itself a large subject that cannot be put away as being outside the normal research and development work. There is no escape from understanding the nuances and taking protective actions in a changing world.

This pathway from a simple academic interested in publishing papers as many significant ones as possible to one who enjoys dealing with a variety of responsibilities has been thrilling to say the least. Finally, it is a pleasure to express my gratitude to the institution that provided the space and time to seek fulfillment of a wide spectrum of aspirations.

Main Building Under Construction

IISc Alumni Association of North America

Thanks

Cookson

Catalysis Research in India

By B. Viswanathan

B. Viswanathan *is with the National Centre for Catalysis Research at Indian Institute of Technology, Chennai. He has been a faculty in the department of Chemistry over 35 years. His research interests include Catalysis, Materials Science, Energy and Information Science. He has over 500 research publications and 20 books to his credit. The establishment of the National Centre for Catalysis Research is one of latest initiatives in the field of science by him.*

Catalysis is a multi-dimensional as well as multi-disciplinary science. It needs the skills of science, engineering, design, fabrication and control, and it draws from all the four branches of chemistry, namely Physical, Inorganic, Organic and Bio as well as chemical engineering and technology. Catalysis is fundamental for improving the various fine and bulk chemical industries. The importance of catalysis will continue to grow in India due to the increasing importance and significance of life sciences, and the rapid development of the interface of biology and chemistry. Catalysis is also important to the developments in material science like the invention of meso-porous and nano materials. The boundaries between the three branches of catalysis, namely, homogeneous, heterogeneous and bio are no longer rigid and have become permeable.

The ultimate aim of research in catalysis is to achieve atom efficiency (that is every atom in the reactant has to be in the desired products so that nothing is wasted), energy efficiency (to keep the cost of production low), environmental friendliness (green chemistry consisting of not only reducing pollution but also giving way to waste treatment and control, analysis and characterization of pollutants) and engineering efficiency (with minimum number of unit operations). From these and other points of view, the science of catalysis seems to have reached a matured state. Interest in catalysis varies from region to region. For example, Singapore has a large petrochemical complex and would look for opportunities for further developments in this area. Countries like Malaysia and India have different raw materials, such as palm oil and bio-diesel. The Asia–Pacific region would do well to emphasize more on these conventional areas. In recent years centers of excellence in catalysis have come up in China, Japan and Korea. These centers have become the focus for outsourcing research by many multinationals.

The science of catalysis is driven by many factors. On one hand, though we want to increase our industrial production, one has to worry how the commercial products and industrial waste materials can be made environmentally benign. Another aspect is the demand of green chemistry for use of products and processes based on renewable materials. The possibilities in this direction appear to be hydrogen from water (through solar cell or photo-electrochemical route) and biomass providing organic chemicals (conversion of sucrose or glucose to lactic acid and oxidation of poly saccharides to useful organic chemicals) and the approach demands a mix of chemical catalysis with bio-catalysis.

Essentially the strength of catalysis today is that it has all the necessary tools. The approaches for studying have also been delineated clearly. However, the integration of theory to practice on a large scale appears to be difficult. The laboratory practice is based on small scale measures whereas large scale production with expected 30% return appears to be asking for the moon. Secondly, since the existing manufacturing plants have high production capacities, it is difficult to integrate the small scale modules with the existing multipurpose production facilities. Also, the know-how generated at laboratory scales are not easily amenable for translation to industrial practice. However, there are opportunities for the developments in this area and they are driven by the society and it is no longer pushed by technology. The needs and demands of the society are increasing and hence the opportunities available for innovation are enormous. The threat one will have to face in this endeavor is the link between legislation, industry and research. The consistency and understanding of the importance of catalysis by these three agencies are the key factors that would determine the growth of research in this field. Also there is the fear that industrial research is confidential while academic research is focused on transfer of knowledge and therefore the two cannot be merged. Against this background, it is necessary to see what aspects of

catalysis will dominate in future. The list given below is in no order of priority.

1. Exploiting solar energy for the production of hydrogen and other chemicals:

It will be good even if only 1 % of the radiation falling on the earth is trapped in solar cells which have an efficiency of 15%. This electricity when used for electrolysis of water even with 80% efficiency will become economical and viable. Production of organic chemicals from various sources including waste cellulose or biomass will be another area which will receive attention.

2. Dioxygen as selective oxidant:

Use of oxygen as a selective oxidant will gain importance especially for the partial oxidation of organic substrates. The cleaner oxidants so far utilized are hydrogen peroxide, ozone and tertiary butyl hydroperoxide but they are not economical. Oxygen appears to be a cheaper and least hazardous among the various possible oxidants. Partial oxidation of organic substrates especially hydrocarbons will become increasingly important for the production of fine chemicals.

3. Activation of saturated hydrocarbons and use of natural gas as feedstock:

It may be necessary that our feedstock composition and pattern have to change drastically. This means that we have to learn to activate most of the saturated organic molecules without combusting them. New materials that can act as catalysts for functionalization of saturated organic molecules will have remarkable effect in the production of commodity chemicals in the future.

4. Enantio-selective catalysis:

There are many possibilities in this area and this is an area which has been emphasized time and again. Many homogeneous catalyst systems are well known and anchoring them or utilizing enzymes will be the direction in which this area will further develop. It is also possible that new solid chiral catalysts will be formulated and used for selective synthesis of asymmetric products useful for pharmaceutical applications

5. Photo-catalysis with visible light:

Absorption of photons is a fascinating means for activating molecules but photons are expensive to produce. This problem would be surmounted if one can make use of visible light and work on energy transfer systems which will absorb visible light but activate the molecules in the UV region. This type of energy transfer systems in the form of coupled semiconductors or in new materials will have to be developed in the near future.

6. New Polymerization Catalysis:

New polymerization catalysts based on metal complexes creating site specific metal complexes which can give rise to stereo-regular polymerization processes are challenging propositions. These aspects will be seriously looked into in the coming years.

7. Catalysis for waste water treatment:

Water is an essential material but is increasingly becoming scarce. We need to design ingenious methods to treat wastewater efficiently so as to be able to reuse it. The demand is going to grow more and more and one has to find ways to convert waste water into usable water through a combination of catalysts and photons.

8. Use of enzymes in process engineering:

The engineering processes will be totally changed and conventional catalysis has to be converted into bio-catalytic process requiring less energy and better efficiency. This has to be necessarily done and has to be done rather soon.

9. Development of suitable electro-catalyst:

Energy demands pattern for stationary and mobile applications will change in the near future as the culture and habits are undergoing changes. It is, therefore, necessary that new electrochemical energy devices, either batteries or fuel cells, have to be evolved and this requires development of efficient electro-catalysts.

10. Use of exotic materials for catalysis:

This is one area where new developments in material science and the phenomena associated with these new materials can be exploited for various selective processes.
The Indian catalysis community has many success stories to tell. For example, Encilite (NCL, ACC and IPCL) for

isomerization, the Albene process (NCL), reforming catalysts (IIP,NCL), hydrogenation catalysts (IPCL), refining catalysts (IIT-M and IOC), ammoxidation catalysts (IICT,SPIC), fertilizer catalysts (PDIL), etherification catalysts, both solid and bio systems (IITM), exhaust catalysts (IITM), SCR catalysts (ACC) are some of the typical examples of the indigenous developments of our country.

Catalysis research in India has nucleated around some important centers during the last sixty years. Modern catalysis science and technology in India owe very much to stalwarts like Sir J C Ghosh, Professors S.K.Bhattacharyya and M.V.C.Sastri, Rev.Fr.L.M.Yeddanapalli and Dr K.R.Chakrabarty. They have not only initiated research in fundamental areas relating to Fischer Tropsch and ammonia synthesis but also examined the technical feasibilities of catalytic processes. In the last few decades, some of the national laboratories like National Chemical Laboratory, Indian Institute of Chemical Technology, Indian Institute of Petroleum and many others have been developing catalysts and catalytic processes for the Indian industry.

Catalysis research in India is in the threshold of major advances. Some successful past stories provide the necessary impetus for further investments and likely breakthroughs. Catalyst systems for production of fine chemicals and pharmaceuticals in India are gaining high relevance. Development of expertise in the area of catalysis for deployment in both academic research and industrial applications is crucial. In the expanding base of applications of catalysis in industrial manufacture, Indian industry will have to necessarily take advantage of catalysis for remaining globally competitive. There is an urgent need to catalyze the development of stronger linkages of academic and research institutions with industrial users of catalysts in manufacture. Such a catalyst in the promotion of academy-research-industry linkage in catalysis is the National Center of Catalysis at the Indian Institute of Technology, Madras.

It is envisaged that catalysis research in India will attract the attention of many multinationals for their insatiable product portfolio and this is a great opportunity Indian catalyst community should not miss.

B J. Padshah – The Man behind the Scenes in Setting-up the Institute

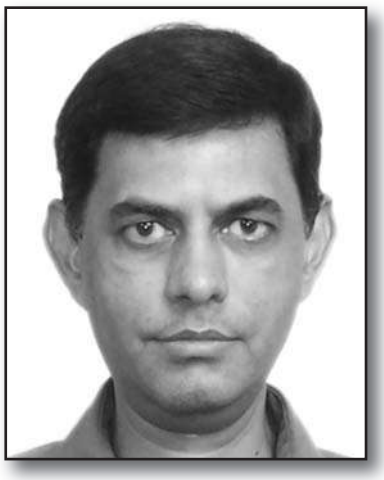
Contributed by A Ratnakar

Burjorji Jamaspji Padshah, a close ward of Jamsetji Tata (Padshaw's father Jamaspji Padshah was a very close friend of Jamsetji) played a significant role in the process of Tata's establishing the Indian Institute of Science at Bangalore. Burjorji was under the guidance of Jamsetji during his early days and became an important member on whom Jamsetji bestowed his confidence and trust. From the time the idea of starting an Institute came to Jamsetji's mind, Burjorji was associated in this endeavour. Burajorji visited leading Institutions in Europe and America to study their structure and gave a report to Jamsetji, which formed a guideline. Later on he liaised with the British Government in various matters connected with establishing the Institute.

Burjorji also shared a close friendship with Mahatma Gandhi.

Suris and Mamidipudis

By M. Giridhar Krishna



Dr M Giridhar Krishna *currently heads the Software organization in Texas Instruments, India that supports the Application Specific Processors and the DLP Businesses of TI. He has worked for Lucent Technologies, and has been the CEO of the Indian operations of Winphoria Networks, a startup acquired by Motorola. He got his PhD from IISc in Aerospace Engineering (1986). His interests include software product development, software engineering, playing and watching cricket, music, books, and most recently playing Golf.*

It has been a while since there has been a Suri or a Mamidipudi in the Institute. If you are wondering who these Suris and Mamidipudis are then read on. One of the Directors of the Institute was Prof Suri Bhagavantam. As you will read elsewhere in this souvenir, Prof Bhagavantam was a great Physicist and had a very distinguished career which included a stint as the Director of the Institute between the years 1957-1962.

My father Dr Mamidipudi Krishnamurthi was one of the 60+ PhDs that Prof Bhagavantam produced. He was also very closely associated with Prof Bhagavantam throughout his career. Not surprisingly, Dr Krishnamurthi also spent 3 years from 1959 to 1962 in the Institute as an Assistant Professor in the Director's lab. During his stint here, he set up a Radio Astronomy group. The group was disbanded when Prof Bhagavantam and my father left the Institute to work for DRDO. The effort of setting up the Radio Astronomy group resulted in one PhD. The person was Suri Ramakrishna (Prof Bhagavantam's son), who got his PhD under the joint supervision of Dr Krishnamurthi and Prof Bhagavantam and went on to become a Professor in the Aerospace Engineering Department. Prof Ramakrishna was also Assistant Director of the Institute during the days of Prof Ramaseshan's directorship.

Prof Ramakrishna set up the Guidance and Instrumentation (G&I) Lab in what was then the Aeronautical Engineering Department in the 70s. The present Associate Director Prof N. Balakrishnan was one of the PhDs produced by Prof Ramakrishna. Inevitably, there were other Mamidipudis who also passed through this lab. The first one was Mamidipudi Nagarjuna who completed his BE in ECE in the year 1978. He worked as a Project Assistant in the G&I lab with Prof Ramakrishna and Balki. Nagarjuna was actually surreptitiously preparing for his IAS exams and he went on to become a very successful IAS officer in the AP cadre. Unfortunately he passed away of Leukemia in the year 2002.

In the year 1979, my brother Mamidipudi Gopi Krishna and I joined the Institute. Gopi started with a BE in ECE and went on to do his MSc Engg with Prof V Rajaraman in the School of Automation. He completed his studies in the Institute in the year 1984. Today he runs a very successful eLearning company based in Atlanta and Fremont. I worked for my PhD with Prof Ramakrishna and Balki and finally got my degree after many trials and tribulations in the year 1986. Subsequently I joined Texas Instruments in Bangalore. The rest as they say is history since a chance decision has turned out be a historic moment in the annals of Indian Industry. Today after a few career moves through Lucent and a startup, I am back at Texas Instruments, heading the software team here. When I left the Institute in 1986, we all thought that the era of Suris and Mamidipudis was going to end. However my youngest brother Ghanashyam Krishna joined the Institute for his PhD with Prof S Mohan that year. He went on to stay there for another 7 years to get his degree and continue his research. Today he is a very successful Prof in the School of Physics at the University of Hyderabad, the Central University in Hyderabad. He was the last of the Mamidipudis in the Institute.

The last of the Suris at the Institute was Suri Venkatachalam. Chalam obtained a Ph.D. from the Physics Department of the

Indian Institute of Science, Bangalore. He did postdoctoral work in Computational Neurosciences at the University of California, San Diego and is currently the founder member of a company called Metahelix in Bangalore.

It is unfortunate this tradition of generations in a family going to the same institute for education has waned. Today it is more than likely that the children of Alumni go to institutions like Harvard, Stanford and the like for higher education rather than study in IISc. One reason could be that it is much more difficult to enter IISc than some of these institutions abroad!

IISc – The Innovation Engine of the Silicon Plateau

By Prabakar Sundarrajan

As CTO of Citrix Application Networking Group, ***Prabakar Sundarrajan*** *is responsible for driving the technology vision, product strategy and architecture. Prabakar joined Citrix via the acquisition of NetScaler Inc. Prabakar has about 25 years of industry experience in a variety of engineering, marketing and executive positions at Exodus, IBM/Transarc, HP, and Intel. Prabakar is a charter member of The Indus Entrepreneurs (TiE) and has mentored several early stage companies.*

When you think of "Silicon Valley", what comes to your mind? Giant electronic firms such as Intel? Huge computer companies like HP? Thundering Web2.0 successes like Google? Venture capital flowing like a river down Sand Hill Road? All of the above, but surely something more!

Silicon Valley has been successful in creating wave after wave of innovation and ratchet up towering venture successes every single time! There have been number of attempts in various regions around the globe to replicate that success. Some areas have been able to achieve a modicum of success, such as the Route 195 around Boston. However, many other contrived efforts, such as Silicon Rainforest around Seattle, Silicon Alley in New York, etc., have not really been able to achieve the critical mass to generate the sustained venture explosion.

There have been numerous analyses on the causes that have uniquely contributed to the success of the Silicon Valley, which can be summarized as: Silicon Valley has succeeded because of the combination of a few major factors: an entrepreneurial (risk taking) culture, availability of plenty of venture capital and this last key ingredient – the presence and more importantly the ***active participation*** of leading educational institutions such as Stanford and University of California Berkeley that gave birth to a steady stream of innovative ideas and bright minds.

Much has been written about Bangalore being the hub of the Silicon Plateau in India. Today, there we can find venture capitalists present in ever growing numbers to find and fund the next big idea. The success of InfoSys, iFlex and others has also given rise to bright eyed, would be entrepreneurs ready to take the world by storm with their ideas. However … in my opinion, something is not quite up to the mark about the combination of ingredients that will rev up Bangalore and truly deliver on the promise of the Silicon Plateau.

That something is the active participation of ***the*** leading educational institution in Bangalore. I am of course referring to my alma mater, IISc. We of course have the ***presence*** of that great institution in that location, but ***active participation*** is what is needed to Bangalore to vault to that next level to spawn grand venture successes.

You might wonder what I mean by active participation. That is best explained by the example of the role played by the Stanford University in the success of the Silicon Valley. Scientific historian Tim Lenoir has extensively researched this aspect and has concluded that Stanford's role as Silicon Valley's technology incubator is clear and has cited several astonishing statistics: "In the last 50-odd years, university faculty, staff and graduates have launched some 1,200 companies. Today, more than 50 percent of Silicon Valley's product comes from companies founded by Stanford alumni -- and that does not even include Hewlett-Packard, one of the Valley's largest firms!"

In addition to Lenoir's analysis, we can also point to several notable example ventures, such as Sun Microsystems, Yahoo and the most recent tremendous success of course, Google, that got their start at Stanford!

One of the key reasons for Stanford's success in fueling ventures, as cited by Lenoir is the encouragement of entrepreneurial

spirit and collaboration with industry. University faculty are encouraged to be entrepreneurial and, overall, have a very high involvement in Valley companies, whether as consultants, advisers, board members or even chief technology officers. A liberal regime of licensing of intellectual property to student and faculty spin-off ventures provides a further turbo-boost.

I do agree that IISc should strive to stake its rightful claim to a place as one of the premier academic research institutions in the world. However, I believe a vital role as a venture incubator also has to be a ***key*** part of IISc's manifest destiny. It need not happen overnight and it does not need to and should not limit to only spawning new ventures. It is the continuous interaction with well established companies along with the incubation and new venture participation that will do the trick.

In order to accomplish that, I would like to suggest a few key actions that must be taken wholeheartedly (tentative half-measures will not do) by the administrators and leading academicians of the institute:

- Actively encourage participation in industry in general and new ventures in particular, by faculty ***and*** students.
- Seek research and course projects not only for fundamental research but also applied research aligned with specific industry defined needs.
- Establish an active regimen of licensing technology innovations to new ventures (also called spin-offs).
- Provide incubation facilities to spin-off ventures, within a research park within or adjacent to the institute.

With the establishment of SID and its initial work with industry interactions, IISc has taken the first key step towards fulfilling the promise as a venture hub. My best wishes and fond hope are for the institute to take further rapid steps and amplify its efforts to achieve the critical mass of success needed for an explosive launch of the second stage towards its manifest destiny as the innovation engine of the Silicon Plateau!

Physics Department: Almost Ready

India Needs a "Pink Revolution": Possible Agenda

By Seyed E. Hasnain

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The problem posed by infectious disease is indeed grave. Since the beginning of recorded history, there has been far more deaths caused by infectious microbes than the mortality figures of all the wars in the world put together, including the latest Iraq war. We continue to witness the emergence of new highly pathogenic organisms such as the bird flu, the SARS virus, drug resistant pathogens including extremely drug resistant (XDR) variants, etc. The flu and SARS epidemics have clearly shown that infectious diseases have no geographic boundaries. Infectious organisms are a global threat causing approximately one-third of all deaths across the world and about 50 per cent in the developing countries. Tuberculosis, HIV AIDS and malaria remain the largest cause of mortality and morbidity in the humans. Despite control measures like effective drugs and preventive measures like vaccines, there are increasing examples of drug resistance and vaccine escapees. As if the pathogen is not enough the Single Nucleotide Polymorphisms (SNPs) in the host genome (that make each one of us what we are despite having over 99% genetic identity) also continue to create new challenges in defying effective control measures.

We are living in an era of "omics" where, whether we like it or not, biology will continue to occupy centre stage for the next few decades. Perhaps the primary impetus for this came from the cracking of the genetic code that makes us human. Hundreds of genomes representing plants, bacteria, viruses and other infectious agents have since been sequenced. It is possible to look at the complete transcription profile (transcriptomics), protein profile (proteomics) and the metabolites profile (metabolomics) of an organism, not just during its life cycle but also when the organism is living in the host asymptomatically or causing a disease. Recent developments and knowledge about the pathobiology of large number of infectious organisms have led to major advances in the treatment and management of infectious diseases. In fact the last 50 years have indeed witnessed unprecedented advancement as a consequence of efforts of scientists, both in academia and industry, leading to the development of diagnostic aids, therapeutic molecules and new interventions to prevent diseases and improve human health.

Despite these positive developments one thing is getting very clear. The more we know about the biology of a pathogen the lesser we know about how they cause the disease simply because the cross talks between the pathogen and the humans continue to remain a major challenge. With the emergence of novel infectious organisms such as SARS and existing diseases like TB, AIDS and those caused by viruses such as Ebola, encephalitis, influenza and chickenpox, there is a need to take effective action. With global boundaries disappearing, food microbiology and safety, and bioterrorism are a cause of concern. It is possible to create a novel bioterrorism agent which will specifically target defined population cohorts simply based on the SNP profile of that cohort based on genetic susceptibility data which are publicly available. The fact that the most deadliest pathogen, for which the entire genomic blueprint is available in the public domain, can be created in the laboratory as was recently shown in the case of polio virus, has created a highly charged debate on what research findings should be made available publicly and what should not be allowed so as to prevent future bioterrorists from creating in the laboratory an otherwise eliminated infectious agent. This has also raised questions about what constitutes a true eradication, in the light of the fact that a pathogen may be recreated in the laboratory long after it has been successfully eliminated from the face of the world.

Need to seed the foundation of a "pink revolution"

The world is united in its effort to address some of the threats to human lives by infectious organism or bioterrorism. Quite often, funding for such efforts is prioritized based on sectoral or geographical needs, or economic "lust" of the developed countries. To successfully address these issues of human health posed primarily by infectious diseases, in the Indian context, one has to start with a reinforcement of the public health systems. Also India is the melting pot for a large spectrum of diseases and is also home to the largest ethnicity in the world. Public health infrastructure is, therefore, critical for a country such as ours. The least said about our Indian primary health care centers the better. This is in sharp contrast to developed countries where both physical and human resources effectively provide a foundation for a solid infrastructure. This is very vital not just in terms of equipment support but also for technical skills and availability of appropriately trained manpower, that are required to quickly address new threats. Disease surveillance by a well-defined and quick acting system is another important step in combating threats of infectious disease whether existing, emerging or re-emerging. Inter-country cooperation in this regard and an effective surveillance system is the key. The use of information technology can be effectively augmented to address this issue. A country like India which has acknowledged international leadership in IT can play a vital role. Public awareness of the same plays an equally important role. The Centers for Disease Control and Prevention in Atlanta (USA) is perhaps the best model in this regard. This, therefore, requires creation of epidemiologic tools and infrastructure and at the same time providing skills and training for medical school students, Ph.D.s and Postgraduates. Diagnostics is another critical factor in the effective management of problems caused by infectious diseases. Appropriate diagnostics will quickly aid in identifying the right intervention strategy. The problem is further complicated with the emergence of new variants which do not fit the typical genetic signature of a known pathogen.

A proper research agenda specific for our country and at the same time fitting the global context is crucial. There are specific pathogens which may be critical for a given country, but as international travel becomes easy and affordable the country specificity is lost. The research should not be looking at the pathobiology of specific pathogen but also the cross talks between the host and the pathogen, the molecular and evolutionary dynamics of the pathogen, persistence of a disease, development of new vaccines, etc. Another essential component is an effective mechanism to propagate and communicate information about the disease process by highlighting the risks to the general masses.

Conclusion

Professor M.S. Swaminathan ushered in the 'Green Revolution' which brought food security to our country by transforming it from a food borrowing nation to an over producer. Professor Verghese Kurien is rightly called the father of "White Revolution" for steering the milk producers' cooperative movement to a level where India became the world's largest producer of milk and dairy products. Unless India positions itself to effectively protect the health of its population and comes out with a grand strategy to implement, what I would like to term a "Pink Revolution", I am afraid the benefits of the White and Green Revolutions will lie by the way side.

Of This and That

By Anita Jhunjhunwala

After her BE in Computer Engineering from IISc and MS in Computer Science from Iowa State University, ***Anita*** *co-founded a software consultancy firm in Calcutta with her husband Animesh, also an alumnus of the Institute, and ran it till recently. She volunteers with several non-profit organizations and is a crisis counselor with the Suicide and Crisis Center of Santa Clara County. She studies and discusses literature, history, spirituality and psychology in her quest to find answers for fundamental questions of life and existence.*

"Does a smile light your face whenever you think of the great days at IISc? Would you like to be in touch with the friends & faculty of yesteryears?", is what I said when I set up a yahoo group in December 2000 to stay in touch with our IISc connections. Whoever has lived at IISc finds it hard to forget the magic of that institute, the beautiful landscape, the flower laden trees, the avenues turning yellow with flowers graciously scattered by the overhead trees create a magical atmosphere that intoxicates and casts a spell on you. But for those who, as Dr Chatterji mentions elsewhere in this souvenir, in addition to getting their professional degrees also happened to find their life partners in and around that campus, IISc remains an enigma that keeps confronting you wherever you go.

After leaving Bangalore for a short stint at Iowa State, I moved to Calcutta, as we used to call that city, to participate in and fulfill the entrepreneurial dreams of Animesh, my friend and mentor since IISc, but Calcutta doesn't have a high density of IIScians. Moving to the San Francisco Bay Area in 1999 was almost like coming to an oasis as far as IIScians are concerned. Perhaps the fourteen years that had elapsed (a whole *vanwas?*) had made them more precious! The best was meeting and exchanging notes with other IISc-couples of our times -- Revati and Kumar, Kaberi and Tarun, Meenakshi and Amit, who, presumably are under the same blissful/miserable condition.

And then it wasn't enough to just meet in each other's houses. So, in February 2000, I sent out an email to some of our friends: "no house is big enough to hold all of us in the bay area☺. So, we thought of a get-together in a hall in some restaurant…" The idea was to transcend the boundaries of batch and professional stream, and meet as we did four times a day in the "Mess" in good old days. The proposal was greeted with an overwhelming enthusiasm and support, and finally the morning of Sunday, 5th March 2000 saw fifty of us in the banquet room of '*Swagat*' in Mountain View. It was fun, almost intoxicating to bump into so many faces after such a long time, compare notes, and watch how each person has changed. That day, the newborn, fledgling Alumni Association made a profit of $47 and I was assigned to guard that treasure. Amongst the organizers were Gopi and Kamesh, a couple that has been a constant face on the horizon of Alumni association since then; and we've often discussed that Kamesh should be made an honorary IIScian☺.

Buoyed by the success of that first meeting and the flurry of emails, and the growing popularity of the new technology, the yahoo groups, I set one up in December 2000 with approximately 64 members. The group included our friends in India and other countries and the idea was a friendly, carefree exchange on any idea that struck one's fancy, in a supportive atmosphere. We were all friends and we needn't agree with each other opinions but at least it could've been a forum where we voiced our thoughts on a subject. Unfortunately, however, that dream hasn't lasted. As more and more people joined, a few vociferously objected to anything and everything. So gone were our dreams of exchanging ideas, opinions on current affairs, politics, and social issues.

Since 2000, Silicon Valley has seen annual get-togethers of IIScians, most of them around the Founder's day of March 3, where around 100 people show up. In addition, there was a spell when we had informal monthly meetings, organized mainly by Kim Singh and Gopi, featuring an IIScian or a visiting professor, and we've had picnics, hikes and games such as *Antakshari* and Dumb Charades, where everyone participated. Several independent IIScian groups have coexisted in the Bay Area and

we've actively collaborated and merged with them under one umbrella, whenever possible. At one point, we leveraged our software consultancy firm to put up a website for IIScians, which was used enthusiastically between 2001 and 2003, and had over hundred registrants.

The interesting characteristic has been that every year, a new set of IIScians take the lead, some stay on for a few years and then move on as their priorities in life change. From an informal gathering of fifty to a formal gathering of almost ten times that number, and where the institute is actively participating is a kind of dream come true. The credit for this goes to many dedicated IIScians who volunteered for literally hundreds of hours for their alumnus. I wish I could list them here, just as a small tribute to everything they did, but I'm afraid of unintentionally missing out names, something that I don't want to do.

Let us now leave the past behind and move on to the present and the possible future. What are the biggest problems society faces today? Have the stress, depression and mental health issues increased throughout the world in the last 25 years? An event at IISc that affected me to the core, changed my thinking and in a way defined my mental makeup was the suicide by a research student, who I thought I knew reasonably well. The shocking news around the lunch hour found us all gathered around the "M" block. "What happened? Is it really him? Why? When? How?" were some of the questions we were battling with, when an auto stopped in front of us and a man stepped out looking lost. As my eyes focused on him, I recognized a good friend of my brother, the brother of the dead student. I moved towards him and the next two days are a blur. We went to the morgue; we were in the director's office; we were traveling in a car; we picked up the coffin; we talked and talked; his pain was unbearable, the trauma and anguish that he faced at the loss of his younger brother showed me what suicide victim's family goes through.

More than twenty years after that incident, I became a suicide and crisis counselor, an exaggerated title for someone who simply works at the 24x7 crisis hotline. Listening to hundreds of hours of crisis calls, I believe that one commits suicide because one finds the situation unbearable, sees no way out, and wants to somehow escape the pain. I haven't yet figured out whether the soul still exists after death, still torments in a hell, but I do know that a new chapter of pain begins for the family and loved ones. Perhaps the student need not have taken the final step if he had access to a crisis hotline, and such a line would certainly have helped the brother and other members of the affected family.

What exactly should be the role of an Alumni Association? Apart from an annual get-together or even a conference from time to time, what are the other activities that would add value to our friends' lives? At IISc, we lived like an extended family, eating and working together. Shouldn't the alumni, therefore, create an "SOS Helpline for IIScians"; the goal – unconditional support for anyone in crisis! Just as extended family does not ask questions on what or who is right or wrong, it just supports its own, knowing that it is human to err, so would this unit. We love you; we want to be with you if you are in crisis, or experiencing a low in your life. We believe life is not necessarily fair, and that you do not necessarily deserve what life has dished out. We may not be able to solve the problem you are facing but we'll battle alongside you as you face your *Kurukshetra*. We do not have all the answers but we can multiply the number of eyes that look for a solution for whatever you are facing. IISc provided such support structures (though they didn't help the student who committed suicide) and so did the joint family prevalent in India. In the last few decades, however, the Indian family structure has broken down and the support system for an individual is lost. Could the Alumni Association fill that vacuum?

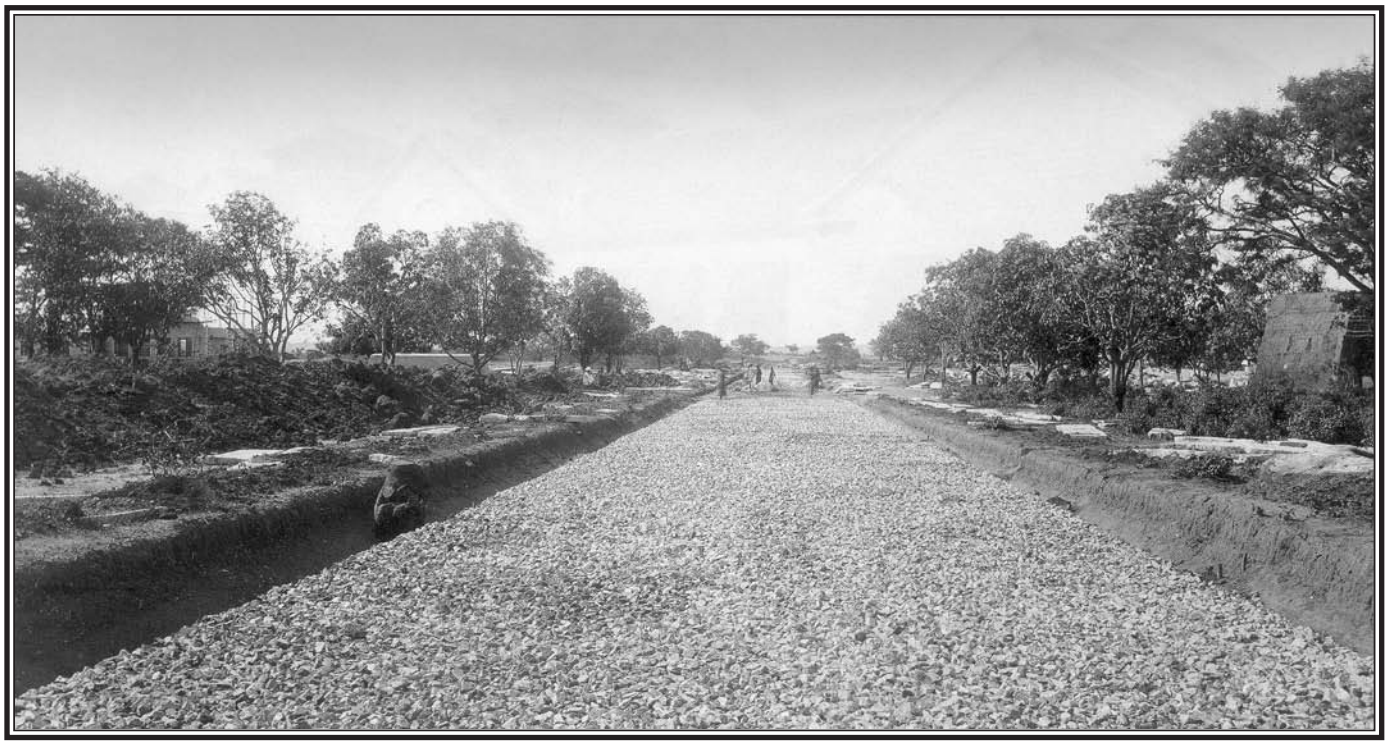
What, if any, are the gaps in our education at IISc? As Dr Roy says in his article in this souvenir, we need "Science for the Citizen" and he illustrates his point quite well with a humorous anecdote about the graduates of Harvard and MIT; IIScians, I'm sure are in a very similar boat. IISc has created an isolated world, a utopian world, where the members stay in the dream world of their research; it sprouts and nurtures "Experts" in various fields, but perhaps not citizens, who know how to deal with issues in the ordinary world. One would expect that a premier institution like IISc produces social leaders, leaders who can steer the society in the right direction, who can guide and carry the common person along with them. And for that perhaps, IISc needs to offer courses in humanities where one learns of the issues facing India and the world, in critical thinking, where one learns to question the printed word, in our spiritual heritage, where one learns to form and express one's

opinions and value system. In addition, some of the training given to crisis counselors could perhaps be modified and given to the students of IISc; that would, hopefully make them more equipped to deal with, and support others in a crisis, or other real-life problems.

President Kalam, in the 16th JN Tata Lecture[1] delivered in 2006 expressed it beautifully, "It means that economic prosperity alone is not sufficient. It has to be complimented with the value systems and our five thousand years old Civilizational heritage which has genetically shaped the Indian people. I personally believe, when the nation is progressing towards economic development, it is also essential to build education with value system drawn from our Civilizational heritage". And the third action-item in his vision for IISc and the nation is, "Making the studies in humanities compulsory for all students at graduate, post-graduate and Ph.D. level".

It is time that we reassess the goals of the premier institutes in India. Are their graduates touching and improving the lives of those around them? Are they really learning responsibility for self, family and society, or do they acquire a sort of detachment from the problems and troubles others face, as they get too engrossed in their own issues? They might have learnt or could learn to invent the best technology in India or world, but does the world today really need only newer and better technology? Or is technology already outpacing the development of human psychology, emotions, and humanity?

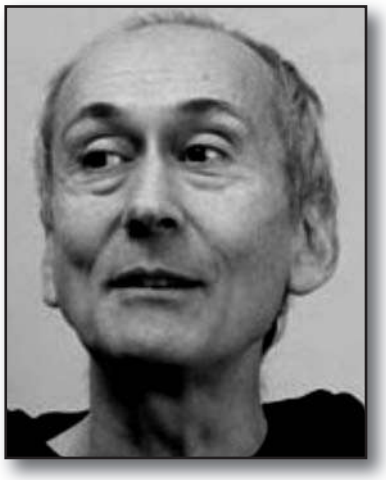
1. The full text of the lecture is available at http://www.freewebs.com/rajshekar/apjabdulkalam.htm



Alluring Gulmohar Marg to ECE Department
(While under Construction)

India, Open Access, the Law of Karma and the Golden Rule

By Stevan Harnad



Born in Hungary, ***Stevan Harnad*** *(http://www.ecs.soton.ac.uk/~harnad) is Canada Research Chair in Cognitive Science at University of Quebec/Montreal and Professor at Southampton University, UK. His research is on categorisation, communication and cognition. Founding Editor of Behavioral and Brain Sciences (http://www.bbsonline.org/), Psycoloquy (http://psycprints.ecs.soton.ac.uk/) and the CogPrints Electronic Preprint Archive (http://cogprints.ecs.soton.ac.uk/), he is Past President of the Society for Philosophy and Psychology, Foreign Member of the Hungarian Academy of Science, and author of over 150 publications.*

India is peculiarly positioned to help herself while helping the entire planet as well. There are Haves and Have-Nots in every domain, and research is no exception: some have more access to laboratories, equipment, grants, and research literature, and some have much less. Laboratories, equipment, and even research funding are analog. They are physical resources that are finite and unequally distributed. But the research literature is digital, and both in principle and practice, it could be made freely and equally accessible to one and all. And very much hangs upon its equal distribution, because research productivity and progress depend critically on having full access to current and past research findings. They are what current and future research is built upon, and from.

There exist about 24,000 research journals across all fields of science and scholarship, the world over, in all languages. They publish about 2.5 million articles a year. Access to those articles is very unevenly distributed. There are Haves and Have-Nots, among the planet's universities and research institutions, but even the Haves can only afford a fraction of the whole. Even Harvard, the university with the largest journals budget of all, cannot subscribe to them all, and most other universities have far smaller journal budgets. Yet the irony is that the authors of all those articles – researchers -- have always given them away for free. They give them to their publishers, asking for no fee or royalty from their sales in return; they also give them away for free to anyone who writes to them requesting a reprint: In paper days this requesting and sending was by mail; in online days it is increasingly by email.

To Indian researchers, requesting reprints by mail has always been critical, as India of course is very much on the Have-Not end of the world's journal subscriptions. Yet India is not on the Give-Not end for research output. Requesting and sending reprints certainly comes nowhere near solving the problem of providing even access to all for all, but it has been a godsend for some, and as a result, India is not just a net consumer of research from the rest of the world, but also a significant provider of research to the rest of the world. The question to be asked in the online age, however, is whether email reprint requests are enough to provide the research access that India needs, and whether India's research output is getting all the impact it deserves.

Research impact means research uptake, applications and citations: To what extent are my findings being read, used, and built upon, in further research and research applications? We are accustomed to thinking of the lack of access to research as being a handicap for the research consumer, but it is a handicap for the research provider as well. Less accessible research is also research that is failing to achieve its full potential impact. And research impact brings visibility, funding, and further research progress. Yet the online age has already provided the means to solve both the research access and the research impact problem completely: Instead of having to mail or email authors to request reprints of articles, one by one, researchers can access the 'eprint' of the article directly, free for all ('Open Access', OA), on the web. – Or at least they could do so, if the 2.5 million annual articles were all being deposited ('self-archived'), free for all, on the web. The problem is that only about 15% of them are currently being self-archived spontaneously by their authors.

OA has been demonstrated to double research impact. The question of why researchers who have always been giveaway

authors, writing only for impact, not for income, are not yet all making their articles OA by spontaneously self-archiving them free for all on the web is one that will have to be addressed by future historians of science and scholarship. That question pertains to a worldwide process and it cannot be answered here. But the question we can address here is what India has been doing and can do to hasten the optimal and inevitable outcome, which is 100% OA.

India has already made important contributions to the growth of OA, thanks to the efforts of its tireless arch evangelist, Subbiah Arunachalam, as well as the invaluable initiatives of Prof. N. Balakrishnan and the late T.B. Rajashekar, who created one of India's first OA archives at the Indian Institute of Science, and did a great deal to encourage self-archiving by IISc's researchers. But the years of continuing access and impact loss since the advent of the online age have taught us that creating archives and arch evangelizing are not enough. Researchers the world over have indicated in several surveys that they will only self-archive if their institutions and/or their funders mandate it. Hence there is now a worldwide movement toward mandating OA self-archiving.

India already has 24 OA archives, 19 of them institutional. The biggest is IISc's with over 7000 documents deposited to date. In addition, one of the 11 institutional OA self-archiving mandates so far adopted worldwide is Indian (National Institute of Technology, Rourkela) and there is also an Indian governmental recommendation from the National Knowledge Commission to mandate OA as a condition of research funding (out of 14 funder mandates adopted and 4 more recommended, worldwide). India has also hosted and produced the Bangalore Policy Statement, a draft National OA Policy for Developing Countries.

This is already an impressive record, but India could do so much more, so easily. It needs to actually adopt a national OA self-archiving mandate for all of its research institutions and funders. The principle is simple; it is already embodied in India's Law of Karma as well as in the West's 'Golden Rule': 'Self-Archive Unto Others As You Would Have Them Self-Archive Unto You'. If India sets the example by officially adopting and implementing this rule, India's own research access and impact will be maximised, the rest of the world will follow India's example, and research progress worldwide will be the beneficiary. Here are some references for those who want to learn more about the importance of and need for adopting open access:

Arunachalam, Subbiah (2006) Why India Needs Open Access. Open And Shut. May 5 2005.
http://poynder.blogspot.com/2006/05/why-india-needs-open-access.html

Harnad, S. & Carr, L. (2000) Integrating, Navigating and Analyzing Eprint Archives Through Open Citation Linking (the OpCit Project). Current Science 79(5): 629-638. http://www.ias.ac.in/currsci/sep102000/629.pdf

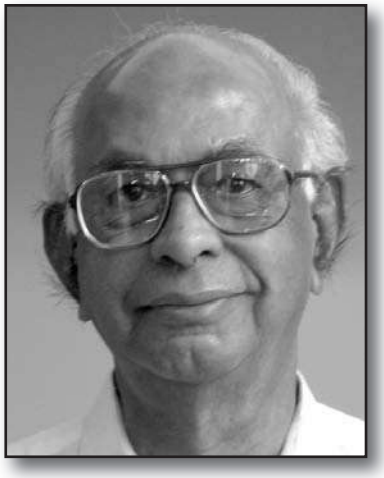
Harnad, Stevan (2006) Promoting Open Access to Research. The Hindu. November 1 2006.
http://www.hindu.com/2006/11/01/stories/2006110104991100.htm

National Open Access Policy for Developing Countries. Indian Institute of Science. Bangalore. 3 November 2006.
http://www.ncsi.iisc.ernet.in/OAworkshop2006/pdfs/NationalOAPolicyDCs.pdf

Suber, Peter & Arunachalam, Subbiah (2005) Open Access to Science in the Developing World. World-Information City. October 17, 2005. http://www.earlham.edu/~peters/writing/wsis2.htm

Turning IISc into a University, the Man Who Made It All Possible

By M. Krishnamurthi



***M Krishnamurthi** has a PhD in Physics from Osmania University, worked as a Post Doctoral Fellow at Ohio State University and Cal Tech, and was an Assistant Professor at IISc from 1959 to 1962. He joined DRDO in 1962 and later the Cabinet Secretariat, Govt of India, to set up technical means within our borders to collect information about missile and nuclear weapons development in our neighbouring countries. He retired from DRDO as Chief Controller R&D in 1984. Since then, he is involved in social work for abolition of child labour and universalization of elementary education through the MV foundation. A long time student and associate of Prof. Bhagavantam, he has four sons, three of whom are alumni of IISc.*

Professor Suri Bhagavantam became Director of the Indian Institute of Science, Bangalore in succession to Professor M.S. Thacker in the year 1957. By then Bhagavantam had a formidable reputation nationally and internationally as an eminent physicist and also as an able administrator. He became a Professor at the Andhra University at the very young age of 28 years. He also served as the Principal of the university colleges in the difficult years of 1942 onwards when the freedom struggle was at its peak and students were constantly agitating against the foreign rule. Bhagavantam, while taking some action against a few students who became very active in the struggle, ably acted as a buffer between the government and the students in most cases. In 1949 he moved over to Osmania University as Professor of Physics and Director, Physical Laboratories. By 1952 he became Vice Chancellor of the University and held the post until he took over as Director, IISc in 1957.

Professor Suri Bhagavantam

As Vice Chancellor, Dr Bhagavantam, galvanized all departments of the University into undertaking high level research and produce PhD's in the languages, humanities and sciences. He himself continued to be Director, Physical Laboratories where he guided a number of students for PhD. In all he produced more than 60 DSc's and PhDs at Andhra and Osmania Universities between 1935 and 1957.

For one year in between he was in England (1948-49) as the first Scientific Liaison Officer at the Indian High Commission. While in England he was invited to visit a number of universities in that country as well as in Europe. He was able to establish personal contact with a number of scientists in Britain as well as Europe including the Soviet Union.

With this background, Bhagavantam ably conducted the affairs of the IISc for 5 years. One principle he followed assiduously was not to interfere in the internal affairs of any Department. He insisted that the Heads of Department and their colleagues in the Department must cooperate and run their departments. In fact, there was some serious trouble between the Head of Metallurgy Department and his colleagues. Both wanted the Director to intervene, but he advised them to settle their differences internally. Having been a Professor himself for long, he respected the autonomy of the Departments so far as their internal management was concerned.

Two important events took place during his tenure. The first one was the Golden Jubilee celebrations of the Institute. They were conducted in a dignified and organized manner but at the same time in a relaxed way. High dignitaries like Prime

Minister Nehru, Maharaja of Mysore, JRD Tata and others participated in the celebrations. Mr Tata was highly impressed with Dr Bhagavantam with whom he came into close contact during the preparations and actual celebrations of the Golden Jubilee. He found Dr Bhagavantam to be an erudite scholar, brilliant conversationalist and a person with a great sense of humor. The other important event was the attempt by the Department of Education, Government of India to take direct control of the Institute which would have seriously affected the autonomy of the Institute. Bhagavantam skillfully prevented this from happening. Instead, he got the Government to recognize the Institute as a deemed University which meant that the Institute came under the purview of the University Grants Commission and the Institute could award its own degrees such BE, MS, MTech, PhD, DSc etc. He also introduced the practice of merit promotions whereby a member of the faculty could be promoted to a higher post, if considered fit, without waiting for a vacancy to occur at the higher level.

By 1960, Mr. VK Krishna Menon who was then Defence Minister started pressurizing Dr Bhagavantam to become his Scientific Adviser. After a year of persistent persuasion by Mr. Menon, Dr Bhagavantam agreed to take up that position while continuing as Director, IISc. This he tried for one year from April 1961 to March 1962. He found he was not doing justice to either post as he had to constantly move from Bangalore to Delhi and back. So in April 1962 Bhagavantam left IISc and moved over to Delhi as whole time Scientific Adviser to Raksha Mantri. Thus ended his connection with Indian Institute of Science.

In the short period he was in IISc, he set up the Director's Research Laboratory in 1959 where I had the privilege of working with him. In the three years between 1959 and 1962, two PhDs were produced and a third one was underway. Thus Dr Bhagavantam continued his scientific pursuits even while carrying on his onerous administrative duties.

Inside Story of the Main Building

Encouraging Radical Discovery

By Ronald N. Kostoff

Ronald Neil Kostoff *received a PhD in Aerospace and Mechanical Sciences from Princeton University in 1967. At Bell Labs, from 1966-1975, he performed technical studies in support of the NASA Office of Manned Space Flight, and economic and financial studies in support of AT&T Headquarters. At the U.S. Department of Energy, from 1975-1983, he managed the Nuclear Applied Technology Development Division, the Fusion Systems Studies Program, and the Advanced Technology Program. At the Office of Naval Research, from 1983-present, he established a new effort in textual data mining. His interests continue to revolve around improved methods to assess the impact of science and technology, incorporating maximal use of the massive amounts of data available.*

The 2006 USA National Academies' report "Rising above the Gathering Storm" (1) addresses the challenges to the USA of globalization, and the adequacy of USA science and technology enterprise to respond to those challenges. The challenges may even be more serious than indicated in the report. Our recent text mining study of China's core science and technology competencies (2) shows that when research outputs are dis-aggregated by critical sub-technology areas, China is a competitor in many critical sub-technologies now. Aggregate comparisons, at the country or broad technology level, can produce misleading results, and understate the seriousness of the problem.

The National Academies' report provides a number of recommendations, two of which are (1) enhancement of innovation (and by implication discovery) and (2) enhancement of high-risk high-payoff research. These two selected recommendations are extremely important for countries that have a high-wage technical labour force, such as the USA or the UK. Innovation and discovery allow high-wage countries like the USA or UK to remain competitive against low-wage countries with large numbers of well-trained scientists and engineers, such as China and India.

Promotion of innovation that allows leap-frog advances often requires insights from very disparate disciplines. However, identifying and assembling the right mix of disciplines for maximal acceleration of discovery and innovation is a major challenge, and today is mainly done sporadically and serendipitously.

In the UK, the recent report "Science and Innovation Investment Framework 2004-2014: Next Steps" addresses the need for interdisciplinary research throughout. In the section on promoting high-risk high-payoff research, the report states: "The Research Councils keep the peer review process under review to avoid any barriers for funding innovative and interdisciplinary research. There is still some concern that the UK system has traditionally channeled research along specific disciplinary silos, which may unintentionally give preference to work in established fields." The report does not propose solutions for how interdisciplinary teams could be improved, but rather invites comments from the readership on "measures to remove any remaining bias which unfairly favours established research fields over innovative ones."

In the USA, both the National Science Foundation (NSF) and National Institutes of Health (NIH) have taken actions to develop systematic and methodical approaches to assembling such multi/ inter-disciplinary research teams. In the NSF, a Task Force on Transformative Research has been established. The goals of its December 2005 Workshop can be summarized as: "(1) identifying a process for selecting individuals and ideas to maximize the opportunity for transformative thinking and research to occur, and (2) organizing an experiment to compare such a new system with what is in place today." In the NIH, a Roadmap for Medical Research has been established. At the core of this initiative are multidisciplinary research teams. Both the NSF and NIH concepts centre around the need to efficiently assemble mixes of individuals/disciplines most appropriate to solving target problems of interest.

One such approach, or more correctly, a family of approaches has been developed to identify the mix of disciplines, and also mix of people that must be assembled to increase the chances that radical discovery will occur (3). Unless some systematic approaches to identifying this mix of disciplines/people are implemented on a wide scale, initiatives to promote high-risk

high-payoff radical discovery will never come close to their full potential, and radical discovery will remain a sporadic serendipitous process. The tools now exist that allow us to do better (See Appendix for some examples).

In addition to providing mechanisms for identifying optimal discipline mixes, actions are required to provide incentives for, and remove barriers to, the conduct of multi/inter-disciplinary research. There are many institutional and cultural barriers to the performance of multi/inter-disciplinary research, and these must be addressed and removed if progress is to accelerate.

REFERENCES

1. "Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future". Committee on Science, Engineering, and Public Policy. National Academies Press. 2006.

2. Kostoff R.N. et al. "The Structure and Infrastructure of Chinese Science and Technology." DTIC Technical Report Number ADA443315. (http://www.dtic.mil/). Defense Technical Information Center. Fort Belvoir, VA 2006.

3. Kostoff, R.N. "Systematic Acceleration of Radical Discovery and Innovation in Science and Technology". Technological Forecasting and Social Change. In press. Also, Kostoff, R. N. "Systematic Acceleration of Radical Discovery and Innovation in Science and Technology". DTIC Technical Report Number ADA430720 (http://www.dtic.mil/). Defense Technical Information Center. Fort Belvoir, VA.

APPENDIX – LITERATURE-RELATED DISCOVERY

We have developed multiple approaches for performing literature-based discovery (LBD), where we generate potential scientific discovery (testable scientific hypotheses) from analyses of the technical literature alone. We have applied these techniques to three medical problems and one non-medical problem.

For the benchmark Raynaud's Disease problem, which has become a rite of passage for anyone proposing a new LBD approach, we have generated almost two orders of magnitude more potential discovery than all LBD researchers who have addressed this problem combined. As we show in an upcoming paper, even this level of discovery is only the tip of the iceberg of what is possible with an adequately resourced study.

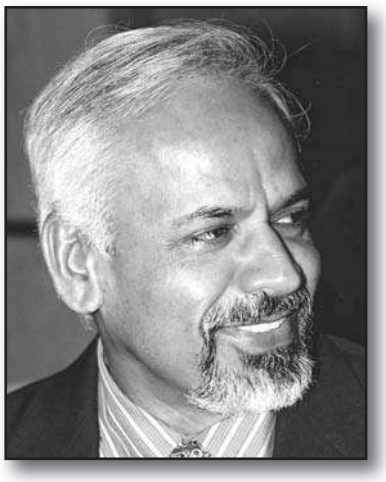
To demonstrate that the Raynaud's study results were not a fluke, we applied a streamlined LBD approach to the problems of cataracts and Parkinson's Disease. In each case, we generated voluminous amounts of potential discovery, with much more potential discovery being possible, and with much reduced time requirements.

The non-medical water purification problem was the first non-medical problem addressed by an LBD approach, and again we generated copious amounts of discovery. Additionally, we used another variant called literature-assisted discovery (LAD), which brought in the larger technical community at the back end of the process, and resulted in many proposals coming from fields very disparate to water purification, with the potential of generating radical discovery.

In conclusion, we have developed and demonstrated a family of systematic approaches for generating and accelerating radical discovery. If the S&T community is truly interested in 'out-of-the-box' thinking, disruptive technologies, and associated radical discovery, the tools now exist for accomplishing these objectives. All that is required is the motivation and will to use them.

In Praise of Serendipity

By K.R. Sreenivasan



K.R. Sreenivasan *graduated with ME and PhD degrees from the Aeronautics Department of IISc. After post-doctoral work in Australia and the US, he joined Yale University in 1979 and taught there for more than 20 years, holding joint appointments in Engineering, Physics, Applied Physics and Mathematics, before moving for a year and a half to the University of Maryland as Distinguished University Professor, Professor of Physics and Glenn Martin Professor of Engineering. In 2003, he was appointed as Director and Abdus Salam Honorary Professor of the International Centre for Theoretical Physics in Trieste, Italy. A Distinguished Alumnus of IISc, he is a member of several professional organizations and has won numerous awards.*

I wish to relate a personal experience and draw a larger lesson. If it looks like a bit of bragging, I assure you that it is needed to set the scene.

In my BE degree from Bangalore University, I stood first not only in my branch of engineering, but in all three branches, and from all three universities of the State of Karnataka. I applied for the ME degree in Aeronautics Department in IISc; my confidence was such that it was the only place to which I wrote. I passed the ME degree in 1970 with first rank: you can still see my name in the roll of honors in the department.

My friends advised me to go abroad for Ph.D. and one of them got me the application for MIT. But I had seen enough examples of first-rate thesis work at IISc. Add to it my own sense of patriotism, and I stayed behind for Ph.D. under the supervision of Professor Roddam Narasimha, a star researcher and a teacher at the time. I learnt a lot from him and it took me roughly three years to complete the thesis. Since I was busy doing other research, I delayed submitting the thesis until 1974; it received the P.S. Narayana Medal for the best in Mechanical Sciences. I was also busy with several other activities such as organizing discussion sessions among fellow students on science, society and philosophy and serving briefly on the council of the student union.

For whatever reason, some of my professors in the department had said to me all along that there wouldn't be a problem if I wanted to join the teaching staff of the department. My goal was thus clearly set: I would join the department and become a professor!

However, an unsought opportunity to go to Australia materialized even before I received my degree formally. When Narasimha visited me there a year or so later, he said that every serious researcher ought to work in a good US university for a couple of years. I thus went off to the Johns Hopkins University in Baltimore, which then had perhaps the best Mechanics Department in the country. There, too, I did pretty well. A year down the road, I told Narasimha that I was ready to go back to IISc; he recommended that I write to the Director, Professor Satish Dhawan, to whom he would send a strong letter of support. Though Dhawan no longer had much contact with students, his glow had touched me briefly on two or three occasions. I promptly wrote to him and waited for the letter of offer to arrive: After all, I had done well by every measure that IISc valued—so what was there to doubt?

How wrong I was! Some seven months went by and no response came. In a moment of dejection, I accidentally saw on a bulletin board the advertisement for an assistant professor at Yale. I asked my post-doctoral mentor, a great scientist, Professor Stanley Corrsin, what he thought of Yale. My ignorance was such that I didn't know that Yale was one of the great universities of the country. As a confirmed skeptic, he said that it was "slightly better than Hopkins in reputation," which meant to me that it was a pretty good place. Frustrated as I was at having heard nothing from IISc, I immediately sent my application to Yale.

I forgot about it pretty much until I received a call from Yale some three weeks later and was asked, "Can you come for an interview?" That was a Tuesday, as I recall. I asked, "When?" The caller said that a seminar slot was open for Friday, if I could make it. Thinking that he meant the Friday some ten days hence, I said "Yes, I can manage, and the ten days will be enough to prepare a talk". He said, "No, no, I mean this Friday". I said, "Fine", and began putting my talk together immediately. The next evening, a secretary in the building took one look at me and said, "Kiddo, let's buy a decent shirt and pair of pants for you to wear for the interview." She drove me to a shopping mall and chose a shirt (which I wore but once), a pair of pants and a tie. My sophistication had not yet reached the level of a jacket.

When I was interviewed at Yale, I learnt that they had interviewed scores of candidates without offering the job to anyone for some four years. I came away thinking that my visit was a waste, but it was only a month later that I was offered the position! It was thus less than two months between my application and the offer. I later learnt how extraordinarily fast it was for the traditionally snail-paced Yale.

It was by then nine months or more since I had written to IISc, and the contrast was obvious: Yale really wanted me and IISc didn't. I took the Yale job. Soon after, however, I received a letter from Dhawan. It began with apologies for the tardiness, which was caused by the fact that he "had been wondering what to do" with me, but he had finally decided to make me an offer (though it wasn't exactly what I had applied for). I wrote back that I had just accepted the Yale job, and so couldn't accept the offer immediately; I would, however, take it next year if it could be kept for me until then. I never heard from him again!

Thus it came to pass that I spent the next 20 or so years at Yale, becoming full professor in six years—soon appointed to a chair with joint appointments in Mechanical Engineering, Physics, Mathematics, and Applied Physics. My work there seemed to have caught the attention of a few people.

In short, for some ten years, I was preparing for a career in IISc, a goal that seemed entirely attainable. I repeat that I had done quite well—there and elsewhere. However, the absence of a timely response, a certain sense of neglect that I felt when my second letter went unanswered, just changed my life plan. The incident left me with a poor impression: when opportunities later came my way to return to IISc, I felt reluctant to do so (Dhawan, however, remained one of my heroes through all this and I got to know him well later; when I was the first Dhawan Professor in the Aeronautics Department, he and his wife came to attend my lecture, which, alas, was the last I saw him).

I have since then accepted the role of serendipity: for, what else could it be that my career was made at a place about which I had not heard until I got there! How I met my wife and how we got married is a similar story. My present position as Director of the International Centre of Theoretical Physics and Abdus Salam Professor was an act of pure serendipity, as well.

Now for the larger lesson: To those younger colleagues who have come to seek consolation because they did not get the one thing for which they had worked hard and long, I have sometimes related this story: Instead of bemoaning your fate of the moment (and you do encounter disappointments), you should perhaps seize opportunities of the moment. This is not always possible and you cannot look for such opportunities actively; but when something that jives with your personality comes along, you should consider it seriously even if you had never before thought of it consciously. You might be happier for it. This philosophy has worked for me.

Amateur Astronomy in India

By Biman Basu

A retired scientist of the Council of Scientific and Industrial Research, ***Biman Basu*** *is a former Editor of the popular science monthly Science Reporter. He has been a regular broadcaster over All India Radio, has scripted several TV documentaries, and published more than 600 articles in various publications. He has 27 popular science books to his credit. He is a winner of the 1994 NCSTC National Award for Science Popularisation.*

Amateur astronomers have played a crucial role in the advancement of observational astronomy, especially in the discovery and study of variable stars, asteroids, and comets. Most amateur astronomers do astronomy as a hobby because they enjoy studying celestial objects. They often observe the sky using nothing more than their eyes, but many use portable telescopes and binoculars. Some even invest in setting up small observatories in their terrace or backyards. In the past amateur astronomers mostly worked in isolation and their work often went unnoticed, except when they discovered a comet, an asteroid, or a new variable star. It is only in the past hundred years or so that amateur astronomy has become an activity clearly distinguished from professional astronomy and other related activities.

In the past six decades, amateur astronomy has flourished mostly in the west, especially in the United States, mainly because of easy availability of small optically superior telescopes and a wide range of observational tools at affordable price. The availability of popular astronomy journals like *Sky & Telescope and Astronomy*, and hundreds of popular books on astronomy has also played a catalysing role in making astronomy popular among the common citizens.

In India, however, amateur astronomers face an uphill task. Good quality astronomical telescopes are either not available or are prohibitively expensive, keeping them out of reach of most amateur astronomers. Good quality popular books and journals on observational astronomy are mostly foreign publications suitable for observers located in higher latitudes (40° N and above), while Indian landmass extends from 8° N to about 38° N. Unfortunately, not many books on the subject are published in India, and even a few that are published suffer from poor production quality and often, factual inaccuracies.

Another problem amateur astronomers in India face is created by widespread burning of biomass as fuel throughout the country, which makes seeing conditions in most parts of the country far from satisfactory. Dirty skies combined with widespread light pollution make the work of amateur astronomers in India, working mainly from cities, extremely difficult. Unless you go far away from the city or go to a hill station, even magnitude-3 stars remain obscured behind a hazy and bright night sky. No wonder not much serious observation is done by amateur astronomers in India, except for a few who can avail of observing facilities at a big observatory like those at Kavalur and Naini Tal.

These problems notwithstanding, a few Indian amateur astronomers have made their mark by their sheer dedication. Radha Gobindo Chandra – a self-taught amateur astronomer in a remote village of British India – was one of the earliest Indian amateur astronomers to specialise in the observation of variable stars. Chandra was one of the early observers of Nova Aquilae-3, seen in 1918, but he failed to communicate his findings to astronomical observatories in Europe or USA in time. He did not realise the significance of his discovery and had taken the brightening of the nova as merely routine rise in brightness of a variable star. In the meantime a European astronomer E.C. Bower got the credit of being the first person to communicate his observational findings of Nova Aqulae-3 on 8 June 1918. However, as a mark of recognition and respect to his findings, Chandra was offered honorary membership of the American Association of Variable Star Observers (ASVSO). He was also gifted a 6-inch refractor, which is now located at the Kavalur Observatory.

84-year-old P. Devadas, the current president of the Tamilnadu Astronomy Association, is another Indian who made a name as an amateur astronomer. He has published papers on the igneous and volcanic origin of the lunar and planetary craters, banded structures on the clouds of Venus, and the nature and origin of Sun and Moon illusion. He also did extensive mapping of the surface of Mars. Though not a professional astronomer, the Royal Astronomical Society, London, elected him a Fellow in recognition of his contributions to astronomy.

Another Indian amateur astronomer Vishnu Vardhan Reddy, who started off with the Amateur Astronomers' Association Delhi, is now pursuing higher studies in astronomy as a graduate student at Space Studies Department, University of North Dakota, USA. In July 2002 he discovered an asteroid (number 78118) while observing from Goodricke-Pigott Observatory in Arizona, USA. It is the first asteroid ever to be discovered by an Indian amateur astronomer. The asteroid was later officially named '78118 Bharat', in honour of the world's largest democracy.

The Confederation of Indian Amateur Astronomers (CIAA) was formed at the 4th All India Amateur Astronomers' Meet in Calcutta, on 22 January 1994. The Confederation is a conglomeration of amateur astronomers and amateur astronomy associations from all over India. It has a scientific advisory committee for support that is required in its projects and endeavours. There are zonal representatives of the CIAA representing Northern, Western, Southern, Eastern and Central India. These representatives coordinate activities in their own region. There are also coordinators for observational, instrumentation and popularisation aspects.

According to the Confederation, there are more than 70 amateur astronomy associations/clubs in India today. But not all of them are equally active. Most are at best dormant groups that exist only on paper. But a few of them are quite active and organise astronomy programmes for the public and carry out sky observations on a regular basis, as was seen during some of the past astronomical events like the total solar eclipse of 24 October 1995, Mercury transit of 7 May 2003, the Venus transit of 8 June 2004, and the total lunar eclipse of 4 March 2007. The large public turnout to observe the total solar eclipse of 24 October 1995 was largely due to the dedicated effort of some of these amateur groups in educating the people about eclipses. In contrast, during a previous total solar eclipse on 16 February 1980, despite clear skies people throughout the country had remained indoors out fear of the eclipse.

Among India's oldest formal groups of amateur astronomers is Jyotirvidya Parisanstha, based in Pune, Maharashtra. It was established in 1944 by a group of eminent citizens of Pune, primarily for the spread of knowledge of astronomy among the public. Right from its conception, the Parisanstha has been actively working for the propagation of astronomy and the spread of scientific temperament. The Parisanstha has been arranging sky shows and lectures, which are open to everybody who is interested in astronomy. It also conducts courses on astronomy, basic as well as advanced astronomy like mathematics in astronomy and astro-photography and organises telescope-making workshops for amateurs.

The Amateur Astronomers Association Delhi (AAAD) has members from all walks of life. Most of them are masters in their own field and have contributed a lot to the development of the association. It is among the few active groups, which regularly organises telescope making and astrophotography workshops in association with the Nehru Planetarium, New Delhi, where the Association's working office is also located. It also organises sky observation sessions for the public to expose them to the thrill of sky watching.

The Astronomical Society of India was established in Hyderabad, Andhra Pradesh, in 1972. At present it has more than 500 members. The objective of the society is the promotion of astronomy and related branches of science in India. The society organises scientific meetings, publishes a quarterly bulletin and supports the popularisation of astronomy and other similar activities. The Bulletin of the Astronomical Society of India is a quarterly journal published in English, which publishes original research papers, review articles, reports on scientific meetings, reports from astronomical centres, book reviews, and conference proceedings.

Delhi-based S.P.A.C.E. (Science Popularisation Association of Communicators and Educators) is one of the most active

amateur astronomy groups working in the field of popularising astronomy amongst the masses. It is a team of eminent astronomers, science communicators and educators, which works for spreading science and an attitude of rational questioning and experimentation amongst children through astronomy.

S.P.A.C.E. is a pioneer in introducing astronomy as a subject in the form of a regular co-curricular activity in the Indian education system at school level. It conducts clubs, courses and workshops for school students in various schools. The group has trained more than 15,000 students in astronomy and are running astronomy clubs in about 80 schools in Delhi and its neighbouring areas, and Jharkhand.

During the transit of Venus on 8 June 2004, which was visible from most of Europe, Africa and Asia including India, S.P.A.C.E. organised a project called 'Vamana' for school children. A transit of Venus observed with sufficient accuracy from two locations on Earth allows the determination of the distance between the Earth and the Sun (also known as the Astronomical Unit, or AU). This measure is crucial for astronomers to know because all other distance determinations in the universe ultimately depend on this value. Today astronomers use other, more precise methods for the determination of the value of AU, but involving children to do the exercise gave them a first hand experience of making astronomical measurements. Students from all over the country participated in the project.

Apart from voluntary amateur astronomy groups, a few academic and autonomous institutions in India have also come forward to popularise astronomy. Vigyan Prasar, an autonomous organisation under the Department of Science and Technology, Government of India, is engaged in the popularisation of astronomy at national level through various means. It conducts telescope-making workshops for school students, teachers and amateur astronomers. It also organises programmes on astrophotography through small telescopes, night sky watching sessions, and meteor shower observations. Vigyan Prasar has been organising special observation sessions for the public during solar and lunar eclipses, and transits of the inner planets, which are very popular.

The Inter-University Centre for Astronomy and Astrophysics (IUCAA) at Pune, Maharashtra, has been doing pioneering work in astronomy education in India at the school level. School geography textbooks in India carry only one chapter describing astronomy, all the way from the solar system to the expanding universe. In order to expose students to the thrill and excitement of astronomy the Centre interfaces with schoolteachers and amateur astronomers. It organises workshops for making sky globes, 6-inch Dobsonian telescopes, and mini-planetariums. The amateur-professional tie-up was fully utilized during the total solar eclipse on 24 October 1995, when an army of young observers, mostly school children, was deployed to trace the path of the Moon's shadow in an attempt to measure the Sun's radius. IUCAA invites secondary-school children to spend a week of their summer vacation working with astronomers. There is also a monthly program, on the second Saturday of every month, of lectures to schoolchildren; the 500-seat auditorium overflows on almost every occasion.

To sum up, amateur astronomy in India still remains a low-key activity with only a few really active groups. Considering the vastness of the country a lot still needs to be done. The efforts of a few active amateur astronomy groups have no doubt helped increase awareness of the general public about celestial events, as seen during solar and lunar eclipses and transits of the inner planets in the recent past. However, if amateur astronomy in India is to become really meaningful and contribute to astronomical knowledge at international level rather than remain confined to conducting telescope making workshops and occasional sky watching sessions, the amateur astronomers' associations/clubs need to devote time for some serious observations that could lead to new discoveries, of comets, asteroids or variable stars, for example. As yet no Indian has put his name on a comet; it is time one does.

IISc Alumni Association of North America

Thanks

TATA Consultancy Services

One Hundred Years of Excellence

By Dipankar Chatterji

Dipankar Chatterji *is ASTRA chair professor in Molecular Biophysics Unit, Indian Institute of Science. He has received several awards like Bhatnagar award, Homi Bhabha fellowship, Ranbaxy award and fellowship of all national academies for biological sciences. He is currently a J C Bose fellow and an honorary professor in Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore. He obtained his Ph.D. from IISc (1977) in Molecular Biology. His current interests are structural basis for nucleic acid-protein recognition and regulation of gene expression in prokaryotes.*

What is so unique about Indian Institute of Science? No discussion of science or scientists or their sociological interaction is ever complete without the mention of IISc. And indeed such an omission would be a simple Freudian slip. Admirers and critics of Indian science equally vociferously cite IISc in their arguments.

In India today, for those aspiring for a research career (both PhD scholars as well as career scientists), IISc tops the list in spite of stiff competition from other contenders. Is it the city and its salubrious climate that draws the young and mature alike? Or is it the names of few reputed individuals which make IISc very special? Several new institutes have come up and more are being planned with the singular goal of attracting the best talents in India for advanced scientific research. Many of these new institutes are better off than IISc in terms of modern "cool" lab facilities, ample space for student and faculty accommodations. Prima facie, apart from a nice climate for which we are not responsible and a beautiful campus (again more credit to nature) what does IISc offer to a student (who should decide at a critical junction of his/her life where to spend the next 5+ years for a higher degree), or a faculty (for several years of his career life)? And at times it is amazing how IISc attracts a major share of both populations.

It appears thus in the last 100 years a process and a standard have evolved; a maturity and quality which roll by their own weight. If I were to rank the several characteristics that make IISc unique, I would put the following two at the top. First, the academic freedom or the avid intellectual nurturing of mind and talent with no boundaries, and second, the propensity of the institute to diversify and embrace new research areas quickly.

Initially, a youngster used to a very structured academic program may find IISc a little aloof and non-interfering and even intimidating. Confronted with the multitude of courses, one is confused but is quick to learn and make their own decisions. The situation facilitates independent thinking. And for the young knowledge hungry mind, the campus is heaven. That is not all: the workshops, seminars, invited lectures, all add to the treasury of knowledge; a vibrant campus fostering cross-pollination of disciplines and cultures. (It is a different story altogether when one also considers how many found their life partners in and around the quadrangle of the campus)

The ambience pushes the individual gently but firmly on a path of excellence. This process has reached equilibrium in the last 100 years and should be experienced to emulate. It is so gratifying to note that every single lecture on every single day in any department is well attended by students and they decide on their own how to manage their time. What a contrast against claustrophobic institutes which push forward students in a predefined direction! Laboratories within don't encourage students to learn anything different, or attend lectures/seminars on topics other than the main research focus of the lab.

For the faculty, it is all this and more; the freedom of self expression, the freedom to collaborate and crossbreed ideas, the freedom to venture out anew. IISc has shown over the years a unique ability to pinpoint areas of research and program that should be encouraged to keep pace with development. Importantly these are done without much hype and one may not notice that a slow change is taking place. It is not difficult for one to look around and find how many departments, new areas,

and programs that IISc has initiated, are emulated later by others.

It is very interesting that over a century, an equilibrium has been established which at times do get perturbed but is never destroyed by external forces. No individual stroke makes a drastic change in the pattern. One may consider this bureaucratic, inertia ridden system, almost Kafkaesque, but perhaps that is the strength of an institute running at high speed underneath.

A Letter from R Raghavachari, a Student from 1935- 1938

Dear Sirs,

My stay at the Institute was between 1935-1938. – Department of Electrical Technology.
(Other - Disciplines in the Institute - 1) CHEMISTRY & 2) PHYSICS).

A Post-graduate Institution, admitted top grade students from ALL OVER INDIA, about 10 student per session.

Students enjoyed absolute freedom in all spheres and could conduct experiments at their convenien The Library was well equipped Provision existed for Indoor and Outdoor games.The Gymnasium Gymkhana offered all facilities for physical exercises.

A studious atmosphere prevailed and students preferred the work in the Laboratory and their studi inspite of diversions.

A compulsory practical training was arranged during the summer vacations at places away from Bangalore and in disciplines – not necessary their subject of study in prestigious professional institutions, situated anywhere in India. A strenuous workshop practise was provided including Carpentry, smithy, machineshop and field survey.

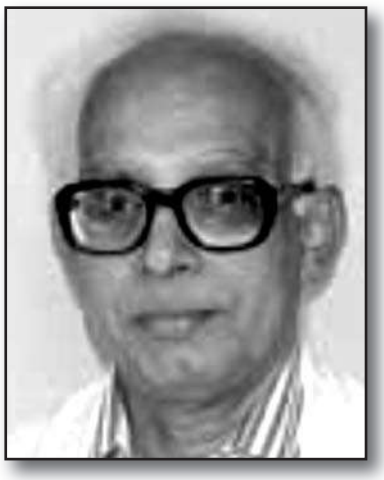
Students were provided with spacious well furnished individual rooms in the hostel in four rows – 18 rooms in a row, with messes at both the end of each row. Being an All India Institution, messe were provided to cater to the tastes of the different regions – MAHARASHTRA – BENGALI – GUJARATHI – PARSEE AND SOUTH INDIAN in all 8 messes and a separate mess for Dayschol

The Institute provided all the infrastructire, including dining tables. Cutlery etc. The students had run the messes – about 10 members in each mess and share the monthly expenses – a Manager bei elected on a rotational basis. The salaries of the mess cooks and servers – One Cook and One Serv in each mess were borne by the Institute.

It was a dream life where one learnt responsibility in a free atmosphere.

Translational Biology in India – Smallpox to Stem Cells

By D Balasubramanian



D Balasubramanian *is currently the Director of Research, Hyderabad Eye Research Foundation. He has also been the Deputy Director and later Director at Centre for Cellular and Molecular Biology (CCMB), Hyderabad; Lecturer and Assistant Professor of chemistry at IIT, Kanpur, India, and Professor and Dean at University of Hyderabad, India. He received his PhD in chemistry from Columbia University, USA. The Government of India conferred upon him the Padma Shri in 2002. The same year, he received the prestigious Chevalier de l'Ordre National du Merite from the President of France.*

As we approach August 2007, we are all set to celebrate the 'shashti abda poorthi' of free and resurgent India. It is time then to look at what all has happened in our country, over the six decades, in the area of translational biology. This relatively newly coined term refers to the application of the ideas and results coming out of basic biological research to human welfare. This might be in the form of selection breeding of grains and crops to increase productivity in farms, birds, cattle and livestock to help the poultry, dairy and veterinary areas, and in human health and welfare. More recently, the phrases 'bench-to-bedside' and the even more evocative 'bedside-to-bench-to-bedside' have been used. Attention of the biological researcher is drawn to what the suffering patient needs and how this need can be addressed by appropriately using the methods and results obtained in the laboratory, and translating them into therapeutic use. In short, this is translational medicine.

In all of translational biology, the attempt is to engage and turn the attention of the laboratory scientist into using the fruits of her findings and applying them to the welfare of the world. Edward Jenner, who turned his question of how some milkmaids are not affected by cowpox into a vaccine, Louis Pasteur who used his results on heat-killing of bacteria to give us the method to make milk safe for drinking, Wilhelm Roentgen who discovered X-rays and used them as a diagnostic tool, and Norman Borlaug whose work on selection breeding of wheat gave us high yielding varieties are some notable translational biologists. One does not have to be the original discoverer of the idea or inventor of the method; he may stay as a bench scientist. But if he transforms the idea or the method into application, he becomes the translator.

India has had a rewarding history of the use of translational biology during its sixty years of freedom and resurgence. This history can be narrated naturally in a decade-wise manner. During the 1950s, when both free India and I were young children, I remember people walking into homes in villages, towns and cities distributing anti-malarial drugs, prompting us to use them and bribing us to do so with free cups of tea. The village post office had free quinine available. DDT was used all over. This was all part of the first drive against malaria, called the National Malaria Eradication Programme. The NMEP-wallahs went all over the country, missing very few areas, and thanks to their efforts the prevalence of malaria came sharply down in ten years.

Even more striking was the smallpox eradication campaign. Biologists of today point out, somewhat off-handedly, that the smallpox virus was an easy one to handle. It did not mutate the way many others do; storing, handling and administering were easy; the people were more willing, and so on. Thank God all this is true, and thank God again we did not need today's more complex biology to eradicate it. The point is that we did it with resounding success. In order to get a feel for it, let us look at the scale of operation. The health workers had to scurry around a land 2,000 km into 2,000 km, handle over 300 million people, obtain, store, transport and administer the vaccine in places reached often using mules, camels or elephants. And eradicate smallpox we did! Alas, the malaria parasite has been tougher to crack, with its drug-resistant strains and with public sanitation measures going down. But given time, there is no reason we cannot conquer malaria. Our little neighbour Sri Lanka is quite well on its way to do so.

If the 1950s was a period of public health measures using this microbial version of translational biology, the next decade of the 1960s offers a different version, this time in food and agriculture. This has been the decade of glory for the agricultural researchers, farmers, policy planners and end-users across our land. Borlaug's experiments with the high yielding dwarf wheat were translated into thousands and thousands of acres by these people. At the same time, better seeds and saplings of rice were found and propagated. Soya, until then an exotic novelty in India, was introduced in a big way. Irrigation, fertilizers, pesticides, post-harvest techniques, and top of them all – acceptance by the farmer and the consumer – led us to the Green Revolution. It was this decade that transformed India from a 'ship-to-mouth' nation into a 'silo-to-ship' one, in ten years.

(On an aside, there has been recent criticism about both the malaria programme and its use of DDT, and the 'excesses' of the Green Revolution, notably the use of excess water (dropping water tables), pesticides (entering the food chain), monoculture (loss of diversity) and so on. Some of these are true, but ones that could not have been predicted at that time, any more than how refrigerant gases have depleted the protective ozone belt around our globe. Such, though, is the nature of our knowledge base and its growth. Progress, however, comes not from staying the course but by doing appropriate course corrections, and trying new ideas for general welfare. And wisdom comes out of learning from what we have done, and finding ways to correct and improve. Had it not been for the steps taken in the 1950s and 1960s, we would still be a hungry and sick nation. But we do need to learn from mistakes – willful and unpredictable – and use rational science and wisdom to go forward.)

The 1960s also brought new institutions of higher learning and research into India. While the IITs have become global brand names over these decades in engineering and technology, the Cinderellas have been the medical institutions such as CMC Vellore, Madras and Stanley medical colleges, KEM and King George hospitals, The Nutrition Institute Koonoor, Haffkine Institute and so forth, which pre-date 1970, but also the re-invigorated ICMR and the newly started AIIMS. These played a significant and collaborative role in focusing attention on the use of biomedical research and practice in improving public health. The fruits of these efforts began to be felt across the country in the 1970s. This was the decade of translational nutrition. Results from biochemistry and intermediary metabolism were used to define what came to be known as protein-calorie malnutrition. The nutritive content and value of Indian food were catalogued for the first time. As the cause of goitre came to be known as the lack of iodine, a successful national campaign for the distribution and use of iodized salt was launched. And as the role of vitamin A in vision became known, the administration of mega doses of vitamin A to school-aged children was started, in order to counteract night blindness and associated aspects of vision impairment.

The enactment of the Indian Patents Act in 1970 has turned out to be one of great public health benefit. The act decided not to honour product patents but did honour and protect new processes by which these products are made. This process patent regime allowed the growth of a large number of drug companies across India, both in the public and private sectors. As the cost of drug plummeted and the number of bulk drug manufacturers increased, the effect on medical care and public health was perceptible. Here is an instance of a different aspect of translational medicine and public health which is not given due credit. As India became party to the WTO patent regime since 2005, this special advantage we had of recognising only process patent has vanished. The government still has considerable freedom in 'unfreezing' many drugs and medical products from this restriction in the larger interest of national health. Despite this, many worry that the medical costs will skyrocket and will be affordable only to the rich. Indian scientists are thus challenged to compete with the big pharma companies and invent new molecules, diagnostics and therapeutic products. How well they meet this challenge and come out winners is being keenly watched the world over. I remain hopeful that there will be several winners.

The reason for this optimism is because of some of the important and exciting developments that were initiated in the 1980s. This is the decade of new biology in India. Several research institutions devoted to modern biology came into being. Some university biology departments re-invented themselves through a 'make-over'. Many Indians trained abroad in the then-newly emerged disciplines of cell and molecular biology, genetic and recombinant techniques, immunology, structural biology and bioinformatics came back to work at these places, brought and taught these to eager students. New medical institutions that included clinical and basic research as part of their charter emerged in the public, non-profit and corporate sectors. And the Department of Biotechnology (DBT) was born. It is from the programmes established by these scientists,

the extra-mural grants and projects initiated by DBT and ICMR (and by DST, CSIR, ICAR, DRDO and DAE) that my optimism stems.

While the 1960s was the decade of the Green Revolution, the 1980s ushered in the White Revolution. What is striking about it is that it did not need 'high science'. What it needed was community participation, ownership and transparency in all its action. This success brought many more community efforts and today India is proudly proclaimed to be among the top producers of milk and dairy products. It was again during this decade that poultry and egg production went up in the country at an exponential level – the Ovine Revolution on the steps of the Bovine. Of course, these are not related to translational biology per se. What they show is the power of community participation, empowerment and enterprise. They have surely made much of India healthier.

Now we turn to the 1990s. This is the decade of biotech companies. One of the first products that was marketed by them was the recombinant vaccine against Hepatitis B. Here was an example of translational biology – not quite bench-to-bedside but bench-to-avoid-bedside. The academia-industry interaction that we were waiting for had arrived. The fact that indigenous production led to a 100-fold reduction in price meant vaccination became more prevalent and accessible to a far larger number of people. It is gratifying to note that today India makes and supplies about 45 percent of the world's need of vaccines against human diseases. The range of products has since widened; although sadly enough, there are few new molecules or materials yet to be made in India. One hopes this will soon be corrected, thanks to the growth of biotech companies in India which had exploded in these fifteen years from a handful to over two hundred. State governments have taken pro-active measures and started 'biotech parks'. The number of academics and researchers turning into biotech entrepreneurs is steadily, though slowly, rising. One hopes this momentum will gather soon so as to generate new products, prosthetics and processes, since of all the industries it is biotechnology that is the major enabler of translational biology and medicine. The recent 'Golden Triangle' effort by the CSIR to bring academia, research laboratories and industry together is a welcome step in this enablement.

The excitement in the current decade in India is the birth, nurture and growth of stem cell biology and regenerative medicine. Here we are truly in the challenge of 'bedside-to-bench-to-bedside'. DBT and ICMR have been major supporters of this branch of biomedical sciences. Stem cells possess two important and useful properties: they have the capacity of self-renewal and the ability to differentiate into any of the hundreds of different types of cells that are needed in order to make the various tissues, organs, limbs and ultimately the organism itself. Each of us is a product of one such stem cell – namely, the fertilized egg cell of our mother. Self-renewal is the ability to multiply faithfully as identical copies without losing or changing any of the properties of the parent cell. The fertilized egg divides repeatedly thus, forming first the eight-cell mass called the blastomere, then the 1,024-cell mass called the blastocyst, then the embryo, foetus and the baby. Harvesting one cell from the blastomere or the inner cell mass of the blastocyst gives us an embryonic stem cell or ESC. Since ESCs have the ability to differentiate into any cell type, they are called totipotent. Much of the hope (and the hype), both in the professional field and in popular press, rests on the possibility that researchers would soon be able to take ESCs and grow then into the desired organ, thus making therapy possible. The field is still in its infancy. Before the dream of generating organs is realised, there is a lot of basic biology that needs to be done: what genes out of the entire genome contained in ESCs are turned on and which are to be silenced; what cell-specific molecules need to be added and what should not; how many cell types are to be generated and how are they assembled into a multi-cellular organ and so on. Indeed, current excitement among cell biologists is to address and answer these above and other questions rather than making organs. They believe that the latter would follow naturally once we have some understanding of the basic biology of these cells. It is in these areas that one might expect the next Nobel to be awarded.

Stem cells are also found in some tissues and organs of the body. Since these occur in tissues that are already a product of differentiation and after the embryo has developed from the multicellular blob, these are referred to as adult stem cells or ASCs. They seem to have the ability to differentiate into several other cell types, though not as versatile as ESCs. ASCs are pluripotent.

ASCs have been isolated from the bone marrow, muscles and one part of the eye. Claims have been made that they are present in the liver, kidney and a few other organs but it is not clear whether these are progenitor cells (develop only into the host tissue), transiently amplifying cells (to help repair host tissue damage) or actual stem cells. This debate will soon be resolved through research; and it is also expected that ASCs will be found in several other parts of the body.

The pluripotency of ASCs is attractive for their use in some therapeutic applications. The favourite source for such purposes is the bone marrow, which provides both hematopoietic (blood cells forming) stem cells and mesenchymal stem cells (MSCs) which can generate other cell types. Indeed, successful therapeutic use has so far been achieved using ASCs and in particular MSCs of bone marrow. In our own country, surgeons have been able to harvest MSCs from the bone marrow of a heart patient (autologous, same body source) and inject them into the patient's heart area during surgery for a myocardial infarct, generate heart muscle cells (cardiomyocytes) and heal the patient. Based on encouraging results obtained in a trial using forty patients, a controlled multi-centre trial is currently on (using several hundred patients) for the cardiomyocyte therapy of MI patients using autologous, bone marrow derived MSCs.

There are also scattered reports of tantalising use of these MSCs in patients with spinal cord injuries, which need to be evaluated and based on which rigorous clinical trials can be initiated. In several such cases, preliminary experiments using animal models have been tried, paving the way for application to human.

Successful use of bone marrow derived hematopoietic stem cells in treating severely anaemic patients has been going on for some time in India, well before the current excitement on stem cells. Here, the so-obtained hematopoietic cells are expanded in the laboratory to the desired numbers and administered to the patient. There has also been a report of the use of such autologous hematopoietic stem cells to treat rats suffering from retinal degeneration in their eyes. Administration of these cells intra-vitrially into the animal has been reported to have generated the desired blood vessel formation. No human experiments have yet been conducted in this connection.

When in 1998 it was reported that the limbus of the eye (the ring-like area surrounding the cornea, abutting the conjuctiva) harbours ASCs, an ophthalmologist harvested them, cultured them to generate the corneal epithelia and transplanted them on a few patients whose corneas were damaged due to chemical or fire burns. Significant restoration of vision was reported. Encouraged by this proof-of-principle, we at our institute initiated this therapy on needy patients in 2001 with success. To date, this limbal stem cell based therapy has restored eye sight in significant measure to over three hundred patients at our centre. Currently, this therapeutic measure is being followed in a few other ophthalmic centres in India.

We have cited but three examples of the successful use of stem cell therapy in India, namely, bone marrow derived stem cells in hematology, in cardiology and of limbal stem cells in ophthalmology. DBT has taken pro-active steps to encourage and propagate the area of stem cell biology and regenerative medicine. It supports work in the area of basic biology of ESCs and ASCs (genetic control, cell biology of differentiation, stem cell specific markers, role of cytokines and small molecules in expansion, maintenance and differentiation, cancer stem cells, etc); trials using animal models (in stroke, GI disorders, liver, retinal repair, etc); and in multi-centric trials using human patients in chosen areas. We believe India has the opportunity to be a world leader in the area of stem cell biology and therapy. DBT plans to establish a series of stem cell research centres, and to liberally support research and applications in this emerging area of translational biology and medicine. Together with the ICMR, it has brought out regulatory guidelines for work in the area. All the factors necessary are being put in place and there is thus great hope that India's aim to become a world leader in this area can be realised in the next few years.

When disease affects one person the doctor fights to win over it and cure the sick person. When disease affects a large number, the fight turns into a battle or even a war. Family doctors engage in fights while public health people engage in wars. The family doctor is concerned with incidence while the public health people are concerned with prevalence. Scale matters here and thus information becomes vital. The branch of science that provides such information is Epidemiology. It gives us data on how many are affected, where all in a given area is the illness prevalent, what appear to be the factors associated with the prevalent illness, and so on. It was information of this kind that helped India roll back childhood blindness, cataract of the eye lens, goitre, and more recently polio. Epidemiology also told us which geographical location in India is polio still prevalent

in. Information of this kind is vital to fight a war and win it. Sadly, the field of epidemiology has become weak in India over the last decade or two, at a time when translational medicine is ascendant. We need to correct this weakness and fast. The existing centres of public health need special shots in the arm. There are a few notable non-governmental centres which have been doing remarkable work in epidemiology, notably on diabetes (e.g., CUPS, CURES) and on blindness (EPIEDS). These and other such efforts need special encouragement. The start of the Indian Institute of Public Health is a welcome move and much is expected of it.

Epidemiology is an informational science, one that helps us in the war against diseases prevalent. Information is a weapon; to be informed is to be armed. To be armed is to be enabled in the battle against the enemy. India has successfully fought and conquered smallpox. It is close to winning over leprosy, polio and goitre. In order that we win other prevalent and emerging diseases, we need translational medicine and public health. The record so far is encouraging and gives us hope and confidence for the future.

A Chemistry Lab in Operation

Inspiring Teachers, Brilliant Students and Few Sportsmen

By Placid Rodriguez

***Placid Rodriguez** has had a four decades' (1960-2000) association with the Indian Atomic Energy Program; the first fourteen years at the Bhabha Atomic Research Centre, Mumbai and the last twenty six years at Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam. From 1992 to 2000, as Director of IGCAR, he led the Indian Program on Fast Breeder Reactors. During November 2000 to October 2003, he was Chairman of the Recruitment and Assessment Centre, Defence R & D Organisation , Delhi. Currently he is a Raja Ramanna Fellow at IIT Madras, Chennai.*

My association with the Indian Institute of Science started as an undergraduate two-year B.E (Metallurgical Engineering) student during 1958 -60. I went back to the Institute in the mid seventies, registering to do my PhD under the external registration scheme. Of my 22 PhD students, 5 obtained their degrees from IISc. Discussions on the work with the co-guides from the Institute and the final viva-voce of these students also were occasions for me to visit the Institute. There were also other occasions provided by the Department of Materials Engineering, the Indian Academy of Sciences, the Electrochemical Society of India, the Materials Research Society of India and of course the Indian Institute of Metals to whose various seminars, symposia, conferences, annual meetings, etc. to which I was a frequent invitee and participant. Since 1980, I must have visited the Institute at least once a year, if not more often.

The growth of the Institute from the late Fifties to the present, to which I have been a witness, has been phenomenal. The visible changes are not only in the number of students and particularly the female population among them, but also the new buildings, names for roads and avenues, the very crowded car parks, the large number of two-wheelers, the new messes and the new blocks of hostels.

If you asked a student in the late Fifties or early Sixties to rank the best in the Institute, the answer would invariably have been The Messes, The Gymkhana, and his Department in that order! It was rumored that many a research student deliberately delayed the submission of thesis to continue to enjoy the Mess and the Gymkhana. In the Gymkhana, Billiards was the most popular, tennis and table tennis, coming after it in popularity. The swimming pool at the far corner near the Director's Bungalow was popular during the summer, but then in those days Bangalore was cool even in the summer. My friend and classmate K. H. Vijayadeva Reddy, who was also the Institute Swimming Champion, and I were regular swimmers and on many days, we were the only ones in the pool in addition to some visitors from Germany affiliated to HAL. There were very few takers for football and hockey and I remember John Vithayathil of the Electrical Engineering Department who was also interested like me in these games and we had a tough time gathering enough players to make two teams.

A V Ramana Rao, a research student in the Department of Metallurgy who later became the (first?) Head of the Department at R. E. C. Warrangal was a legend in sports and games and was the winner of almost all the first prizes on Gymkhana Day. He was particularly superb in billiards, snooker and all racket games! P Rama Rao was another noteworthy player, particularly table tennis. I was good at table tennis, and later at BARC training school I was the Champion, but at IISc, in the Department of Metallurgy team with Ramana Rao, P Rama Rao, and K M Pai (later Professor at IIT Bombay), I could make it only as a fourth member, most of the time sitting in the benches. The Department of Power Engineering also had a strong table tennis team with Bakshi, Batra, and V V K Rama Rao all from the Department of Atomic Energy First Batch Training School , who were sent to IISc for their training. This group of engineers from DAE, and another group recruited for the new steel plants who were in the Metallurgy Department getting trained in iron and steel technology were quite admired and envied by other students as they already had a job and were receiving handsome stipends enabling them to spend weekends more conspicuously in MG Road and Brigade Road

Readers may wonder why, this write-up has an emphasis on sports and games. This is because the ambience at the Institute was a sea of excellence in science and technology, with only a few islands of excellence in sports and games. Therefore, with my interest in sports and games, I could recall the conspicuous few. In this respect I should also mention U B Nayak, also of the Department of metallurgy (and later IIT Bombay), who was a basketball player at the national level.

The B. E. Metallurgical Engineering course, which at that time was only two years duration for those with a degree in physics or chemistry (many students were from three year BSc (Hon) stream and some had even an MSc degree) was really well-designed; it was amazingly comprehensive, covering almost all relevant subjects, from mineralogy to nuclear materials which subjects , today are not included in the four year B Tech curriculum!! The teachers were wonderful and inspiring: Anantharaman teaching physical metallurgy, phase diagrams and heat treatment and Ramachandran (later NAL, Bangalore) teaching mechanical metallurgy; J Balachandra was truly a walking encyclopedia on corrosion, electrometallurgy and nonferrous extraction and Mallikarjunan, a reading encyclopedia on iron and steel . Later on, when I came back to the Department for the external registration PhD, the Department was in the nurturing hands of Abraham and Vasu, two other affectionate and inspiring gurus.

The Institute did a lot of experiments with the B.E program: converted it to a three year programme, then to a four year M.E programme , and finally abolished it . The old post-BSc DIISc programmes, which were converted to post-BSc BE programs in Electrical Communication Engineering, Electrical Technology and Metallurgy were really remarkable assets for the Institute. From these programmes came a large number of leaders in science and technology activities in our country. These programmes were unique in producing engineers with a science background, and in my opinion, the Institute did the greatest mistake in abolishing these courses. The centenary may be an opportune time to look back at some of these old initiatives, reassess them and revive them.

V-shaped Storm Water Drains that still Function
(Road under Construction in front Of IPC)

Attendee List as on June 14, 2007

Aerospace Engineering

1. Arun Nadkarni
2. Ashok Hosangadi
3. Deepak Bagalore
4. Gajanana Birur
5. Giridhar Mamidipudi
6. Neeraj Bollapragada
7. Rama Yedavalli
8. Tarun Bhattacharya
9. Tiruvur Mohanaram
10. Vas Srinivasan

Biochemistry

1. Amitabha Chaudhuri
2. Chakk Ramesha
3. Channa Reddy
4. Eri Srivatsan
5. Ganesh M. Kishore
6. Ganesh Kolumam
7. Gayathri Swaminath
8. Jagath Reddy Junutula
9. Kalathi Thyagarajan
10. Kalyani Penta
11. Manjula Kandula
12. Padala Reddy
13. Rajan George
14. Ramnath Seetharam
15. Sampath Parthasarathy
16. Sekar Boddupalli
17. Shalini Lobo
18. Srinivasa Prasad
19. Subba Rao Gunupudi
20. Sudha Srinivasan
21. Surya Sankuratri
22. Usha Arunachalam
23. Vipin Chaturvedi

Centre for Electronic Design& Technology

1. Balakrishnan Sakthidharan
2. Narendranath Karjala
3. Rajesh Nair

Chemical Engineering

1. Abirami Kaliyaperumal-Kamath
2. Arakere Vasudev
3. Dabir Viswanath
4. Girish Pant
5. Jack Surendranath
6. Mallikarjun Ankati
7. Manthripragada Rao
8. Subrata Naskar

Civil Engineering

1. K Narasimhan
2. Narayan Ramanujam
3. Sanjeev Garg
4. Sridhar Thota

Computer Science & Automation

1. A. Kumaran
2. Abhay Kanhere
3. Anil Edakkunni
4. Anita Jhunjhunwala
5. Arghya Mukherjee
6. Chandrashekhar Kamadolli
7. C.S. Murali
8. D (Jay) Jayasimha
9. Dhiru Pandey
10. Ganapati Srinivasa
11. Gopalakrishna Vadlamani
12. Gopalakrishnan Meempat
13. Gopi Mamidipudi
14. Jay Warrior
15. Kirankumar Vishnubhatla
16. Madhukar Govindaraju
17. Maya Madhavan
18. Mukesh Kapoor
19. Natarajan Viswanathan
20. Prasad Sanagavarapu
21. Prasanta Dash
22. Prashanth Bhat
23. Raj Dhesikan
24. Ramakrishna Akella
25. Ramana Kumar
26. Ravi Palagummi
27. Ravi Govil
28. Sam Balaji
29. Sathiya Selvaraj
30. Satya Ramachandran
31. Shankar Narayan
32. Shipra Agrawal
33. Sourav Sen
34. Sreeram Ravinoothala
35. Sudhir Kshirsagar
36. Sunil Kumar
37. Udayakumar Srinivasan
38. Venkat Manickavasagam
39. Venkatesha Murthy
40. Viktor Prasanna
41. Vipin Goel

Department of Materials Engineering

1. Ashok Sinha
2. Brij Moudgil
3. Homi Dalal
4. Kadthala Narendrnath
5. Kesavan Srikumar
6. Prakash Rao
7. Raj Pathania
8. Sitakanta Hotta
9. Sreeharsha Karnamadakala
10. Subhash Mahajan
11. Surya Pattanaik
12. V. A. Sridhar
13. V Venkateswara Rao
14. Viyay Jujjavarapu

Electrical Communication Engineering

1. Ambatipudi Sastry
2. Anil Chaudhary
3. Ashwin Sridharan
4. Atul Batra
5. Bala Ravikumar
6. Barker Bhaskaran
7. Cauligi Raghavendra
8. Divakar Maddipatla
9. Enjeti Narayanamurthi
10. Govindarajan VS
11. Janardhana Swamy
12. Jitendra Yadav
13. Kannan Raj
14. Krishna Kurapati
15. Krishnaswamy Babu
16. Kumar Narayanan
17. Madhavi Ganapathiraju
18. Mohan Srinivasan
19. Nanda Kishor Velicheti
20. Narendar Venugopal
21. Needamangalam Balachander
22. Pandu Rudraraju
23. Pinaki Mazumder
24. Prabakar Sundarrajan
25. Prafulla Mishra
26. Prathima Janakiram

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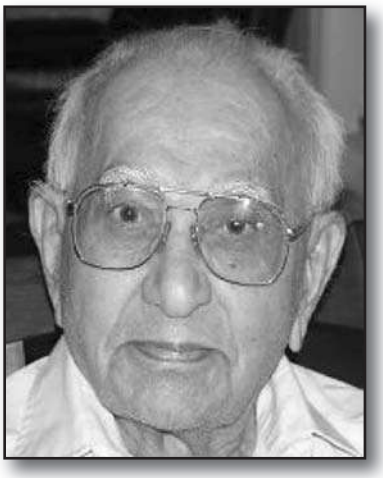
Letter from Centenarian B. S. Ramaswamy



I was born in 1908 in the Hassan District of Mysore State, and after finishing high school in Mysore moved to Bangalore for higher studies. I received my B.Sc. (Honours) degree in Physics in 1929, attending Central College, Bangalore University. Some of the Professors I studied under were Professor Venkatarao Talang, Professor B. Venkateshachar, and Dr. Metcalf.

In 1929 I joined the Indian Institute of Science in the Electrical Technology Department. I received the Certificate of I.I.Sc. (equivalent to B.E.) in 1931, and then the Associateship of the I.I.Sc. (equivalent of M.E. degree) two years later. Professors Catterson, Smith and Moudwalla were on the faculty at that time.

I have many fond memories of my days at the Indian Institute of Science. We were only 100 students at the Institute! Some of the departments in those days included Electrical Technology, Chemistry, Biochemistry, Physics, and Communication Engineering. There were 10 excellent messes catering meals for the different communities. Some of the classmates and friends I remember fondly are Mr. H. K. Ramaswamy who managed the Seshasayee Group of Companies, Mr. H. N. Ramachandra, who after graduation taught for a number of years at the I.I.Sc,, Mr. V. Appadorai, Chief Electrical Engineer for Madras State, and Mr. K. V. Karantha, Chief Electrical Inspector in Madras.

I started my working career in electronics, working with G.E.C. receivers in Madras for a company called Mohammed Ibrahim. I was then recruited by Octavius Steel & Company, which at the time was engaged in production and distribution of electric power all over India. My first job was at Coimbatore, where I helped set up and managed the electric company. I was then involved as Resident Engineer in electric power generation and distribution at Tirunelveli, Tuticorin, Mangalore, Salem and Erode. Later on, I managed established companies in Patna and Muzaffarpur. From 1959 to 1975 I was responsible for the nationwide companies and headquartered in Calcutta. I was made a Fellow of the Institution of Engineers in 1975.

I retired from service in 1975, and moved to the USA as a permanent resident in 1980, since all my children live here. My three sons went to IIT, Kharagpur; but I am glad to say that I have a son-in-law and a daughter-in-law who graduated from the Indian Institute of Science.

In 1982 I had the opportunity to start a company called Ramlak in Sunnyvale, which was the sole exporter of Intel components to India for a number of years. I closed that company when I reached 87 years of age. In a way, I can say that I started and ended my career in Electronics! I am very proud and grateful to have been associated with the Institute. I wish the attendees all the best, and hope that the Indian Institute of Science continues its great tradition of education and research.

27. Priyadarsan Patra
28. R. Sridhar
29. Rajagopalan Srinivasan
30. Rajeev Tyagi
31. Ram Nidumolu
32. Ramamurthy Suresh
33. Ramesh Annavajjala
34. Ritu Shrivastava
35. Sanjeev Ukhalkar
36. Sargur Srihari
37. Seetharaman Ramasubramani
38. Sethuraman Pancganathan
39. Shamkant Navathe
40. Sharad Gandhi
41. Srinivas Kadaba
42. Srinivasan Sundararajan
43. Sundar Durairaj
44. Sunil Kulkarni
45. T. Vijayaraghavan
46. Thirumalai Sridhar
47. Thomas Kailath
48. Vaibhav Natu
49. Vinod Nagarajan

Electrical Engineering

1. Anarta Ghosh
2. Animesh Mukherjee
3. B. Ravikumar
4. Bindi Prasad
5. Daniel Thadikonda
6. Gnana Anandalingam
7. Jawahar Sundaram
8. Joseph Kuriakose
9. Kaberi Banerjee
10. Kedar Parikh
11. Kothandaraman Sridharan
12. Koththavasal Sundararaghavan
13. Krishna Kavi
14. Mahabaleshwar Bhat
15. Maqbool Patel
16. Mohan Goyal
17. Muralidharan Iyengar
18. Nagaraj Patil
19. Nagarajan Subramaniyan
20. Padmanabhan Iyer
21. Parveen Jain
22. Prasanna Mohanty
23. Rajkumar Srivastava
24. Ram [TK] Krishnamurthy
25. Ramesh Vasu
26. Ramesh Ponnapalli
27. Ramesh Seshadri
28. Rashmi Rao
29. Revathi Iyengar
30. Roby Jacob
31. Rohit Kaushal
32. S. Raghupathy
33. Sadanand Karve
34. Sandhya Narayan
35. Sanjay Dwivedi
36. Srini Srinivasan
37. Subrahmanyam Manuguri
38. Vishi Viswanath
39. Vishvanath Hulikal
40. Visweswara Rao Burela
41. Yogesh Alekal

Inorganic & Physical Chemistry

1. Deviprasad Malladi
2. K.C. Adiga
3. M. Gopikanth
4. Seshagiri Mandalika

Instrumentation

1. Muralidhar Ghantasala
2. Nagararaja Chitters
3. Srinivasan Mandyam

Management Studies

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2. Kumar Thiagarajan
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