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From the Editor's Desk

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Chief Editor of Publications

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Engineers are using advanced engineering tools and methods, and at the same time are getting familiar with the tools of modern biology. Quantitative and computational approaches are becoming vitally important in modern biology. We are witnessing the emergence of biology-based-engineering as well as engineering-based biology education. Now engineering schools are joining hands with medical schools to develop different kinds of inter-disciplinary programmes. We are combining the capabilities of engineering and biology to solve molecular and cellular level problems. The fascinating self-assembling, self-repairing and self-replicating 'nanomachines' are getting greater attention of engineers. We are asking how best we can address the problems of life sciences to the engineering students. How much biology is enough for engineering students? In this changing world, 'life' is assuming a new meaning. 'Biological carbon' is becoming the 'silicon' of this century.

Biology and engineering have traditionally represented completely different departments, fields, career paths, even philosophies. But of late, these pursuits have begun to merge in several different ways. There is optimism in the world of life technologies. In order to retain this optimism, engineering and life sciences are coming closer to each other. An engineer's approach to understand complex biological systems is different. Accordingly, life sciences should be taught differently to engineers. There is a view that says that "function-based approach with the idea of nature as the designer and evolution as the design tool" should be followed to teach life sciences to engineers. It means "start with how it works, then talk about the parts."

In this age of 'biologism', biology is very closely interacting with chemistry, physics, mathematics, engineering, psychology, sociology and economics. There is a major shift in the way life processes are being studied and understood. The purpose is to understand intricate dynamic behaviour of individual components so as to better appreciate their integration with the whole.

The first revolution in the engineering of life sciences was due to the developments in molecular and cellular biology. This was followed by developments in genetic engineering. The 'cut and paste technology' allowed researchers to explore inner working of the cells. This enabled researchers to understand diseases at the molecular 'hardware' level inside the cells. Genomics is responsible for the second revolution in biology. The purpose of genomic studies is to look into an organism's entire genome. The second revolution enabled researchers to understand the 'software' that drives cell processes. Due to this revolution, it was possible to sequence the human genome as well as the genomes of many other organisms. Due to these revolutions, emerged many interdisciplinary areas—bioinformatics and computational biology, synthetic and systems biology, nanobiology, biomaterials, and tissue engineering. Convergence of life, physical and engineering sciences is hailed as the third revolution. According to a MIT document, this convergence will be the emerging paradigm for how medical, energy, food, climate, and water research will be conducted in the future. The idea of convergence is to bring closer the technical tools as well as the 'disciplined design approach' traditional to engineering and physics, and apply them to life sciences. Convergence is truly an "intellectual cross-pollination". As a result of convergence, several exciting discoveries are shaping into realities. This is possible due to the coming together of various emerging scientific and engineering disciplines.

ACADEMY ACTIVITIES

INAE Youth Conclave

The INAE Youth Conclave was organized at Birla Institute for Scientific Research (BISR), Jaipur on Aug 11-12, 2017. Dr Purnendu Ghosh, Vice -President and Chief Editor of Publications, INAE and Executive Director, Birla Institute for Scientific Research (BISR), Jaipur had hosted the event. The general theme of the conclave was engineering excellence, youth leadership and nation building. One of the questions often asked is, 'What should we do, as a country, to become the real players in a techno-bulged world? Many say, Prepare young innovative leaders. What must we do – as teachers, mentors and employers – to prepare young minds for the future world? What the young professionals think about the future of engineering profession? These are a few questions INAE addressed in the Youth Conclave. An INAE Youth Forum has been established with the objective of facilitating the engagement of Indian youth in engineering activities at national level. As a first activity of the Forum, with a view to encourage engineering students, a national online Essay Competition for engineering students on 'Towards Technological Self-Reliance and Leadership' was held during the year 2017. The prize winners were felicitated during the INAE Youth Conclave.

The Youth Conclave was a new initiative of INAE wherein around 150 engineering students from all over the country and about 50 INAE Fellows participated in the deliberations. The Youth Conclave was inaugurated by The Chief Guest, Dr K Kasturirangan, FNAE, Chairman, Karnataka Knowledge Commission. The proceedings of the Conclave were interactive in nature, wherein engineering students were encouraged to interact with the Fellows of INAE from the Academia, R&D and Industry. The Inaugural Session was followed by 7 sessions on Engineering excellence, youth leadership and nation building, Award Ceremony and Presentations by essay competition winners, Engineering -An Industry Perspective, Engineering education and Innovation, Entrepreneurship, Start up and Panel Discussion and Concluding Session. This Youth

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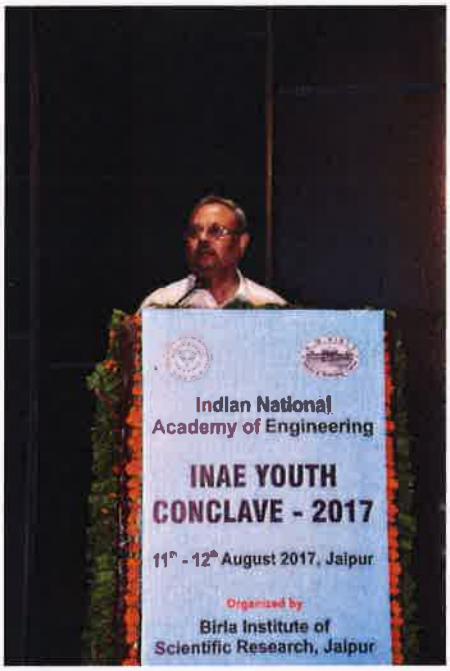
Dr K Kasturirangan, FNAE Inaugurating the Youth Conclave



Dr Purnendu Ghosh, Vice-President, INAE delivering the Welcome Address

Engineers Conclave 2017

The Fifth Engineers Conclave-2017 (EC-2017) is being held jointly with CSIR on September 14-16, 2017 at NAL, Bangalore. Dr Harsh Vardhan, the Hon'ble Union Minister of Science & Technology, Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences has kindly consented to be the Chief Guest to inaugurate the event. INAE had taken an initiative of organizing an annual mega event of engineers as "Engineers Conclave" in the year 2013. The first four Engineers Conclaves, viz., EC-2013 with DRDO, EC-2014 with DOS; EC2015 with DAE and EC2016 with IIT Madras were held at New Delhi, Bangalore, Mumbai and Chennai respectively.

The two themes for Engineers Conclave-2017 (EC-2017) are: Theme-I on ***"Regional Air Connectivity"*** being coordinated by NAL, Bangalore and Theme-II on ***"Digital Economy"*** being coordinated by INAE. These two important themes will focus on cutting edge solutions and specific recommendations for development by the concerned organisations. Eminent experts and senior functionaries from National and State Centres/ Departments/ Units, Academia, Industry and INAE are expected to participate to deliberate on the important themes of the EC-2017. All INAE Fellows and Young Associates have been invited to participate in the Engineers Conclave 2017.

Dr. Abdul Kalam Technology Innovation National Fellowship

INAE and DST have taken an initiative to institute "Abdul Kalam Technology Innovation National Fellowships" to outstanding engineers to recognize, encourage and support translational research by individuals to achieve excellence in engineering, innovation and technology development. All areas of engineering, innovation and technology will be covered by this fellowship. A Maximum of 10 Fellowships will be awarded per year. The scheme has been approved and will be launched shortly and nominations will be sought from the Fellowship.

Annals of INAE

The soft copy of the Annals of the INAE Volume XIV, April 2017 containing the text of the lectures delivered by Life Time Contribution Awardees; newly elected Fellows of the Academy and INAE Young Engineer Awardees 2016 has been uploaded on INAE website under the Publications sub-head. The same can be downloaded from the link given below

http://inae.in/ebook/inae-annals-2017/

INAE on Facebook and Twitter

INAE has created a Facebook and twitter Account to post the news of recent INAE activities in the Social Media. The same can be viewed at the link below.

(a) Facebook -link https://www.facebook.com/pages/Indian-National-Academy-of-Engineering/714509531987607?ref=hl

(b) Twitter handle link https://twitter.com/inaehq1

All INAE Fellows are requested to visit and follow the above to increase the visibility of INAE in Social media.

Important Meetings held during August 2017

- **Selection Committee for selection of awardees for INAE Young Engineer Award 2017** based on presentations by shortlisted candidates held **on Aug 17, 2017 at New Delhi.**
- **Selection Committee for selection of projects/theses for Innovative Student Projects Award 2017** based on presentations by short listed candidates held on **Aug 18, 2017 at New Delhi.**
- **INAE Governing Council Meeting** wherein the main agenda included election of Fellows held **on Aug 25, 2017 at New Delhi**
- **Meeting of the INAE Forum on "Engineering Education" held on Aug 31, 2017 at INAE Office, Gurgaon**

Academia Industry Interaction

AICTE-INAE Distinguished Visiting Professorship Scheme

Industry-academia interactions over technological changes have become essential in recent times so that relevant knowledge that would be sustainable in the changing conditions can be imparted to the students in the engineering institutions. While industries could gain by using the academia's knowledge base to improve the industry's cost, quality and global competitive dimensions; thereby reducing dependence on foreign know-how and expenditure on internal R&D, academics benefit by seeing their knowledge and expertise being fruitfully utilized practically and also by strengthening of curricula of educational programs being offered at engineering colleges/institutions. INAE together with All India Council for Technical Education (AICTE) launched "AICTE-INAE

Distinguished Visiting Professorship Scheme" in 1999. Under this scheme, Industry experts are encouraged to give a few lectures in engineering institutions. This scheme has become popular among industry experts as well as engineering colleges.

Brief details pertaining to a recent visit of an industry expert under this scheme are given below.

Mr S Madivaanan, Formerly Additional Director, CVRDE	Sri Sivasubramaniya Nadar (SSN) College of Engineering, Kalavakkam, Chennai. July 21, 2017	Delivered lectures on "Role of Solid State Drives in Defence Applications". Guided Projects. According to the feedback received from the engineering college, this scheme helps both the faculty members and the students to interact with Industry Expert and enhance knowledge. The students get an opportunity to understand the industrial requirements.

International Conferences/Seminars being organized by IITs/other Institutions

To view a list of International Conferences/Seminars being held in the month of September 2017 click here

Honours and Awards

1.	Dr Baldev Raj, FNAE, Immediate Past President -INAE and Director, National Institute of Advanced Studies, Bangalore and formerly Distinguished Scientist and Director, IGCAR Kalpakkam and Formerly President-Research, PSG Institutions, Coimbatore was conferred the GM Modi Science Award by Gujar Mal Modi Foundation. He was conferred the award by Shri YS Chowdhury, Hon'ble Minister of State for Science and Technology and Earth Sciences, the Chef Guest of the Award Function held on Aug 9, 2017 at New Delhi.

News of Fellows

1.	Prof Mahesh Tandon, FNAE, Managing Director, Tandon Consultants Pvt Ltd, New Delhi has delivered a webinar on July 20, 2017 on the topic "Structures for Spectacular Sports Arenas".
2.	Dr U. Kamachi Mudali, FNAE, Outstanding Scientist and Director, Materials Chemistry & Metal Fuel Cycle Group, Indira Gandhi Centre for Atomic Research, Kalpakkam has assumed charge as Chief Executive of Heavy Water Board (HWB), one of the prime units of Department of Atomic Energy at Mumbai. HWB has seven plants in the country producing heavy water required for pressurised heavy water reactors (PHWRs) operating in India, and also involved in developing many useful materials of relevance to DAE and society (Boron, Sodium, Potassium, Organic Solvents, etc.)
3.	Prof Debabrata Das, FNAE, Department of Biotechnology, Indian Institute of Technology Kharagpur and Dr Shantonu Roy have authored a book on "Biohythane: Fuel for the Future" published by Pan Stanford Publishing Pte. Ltd., Singapore. Prof Debabrata Das has also edited a book on "Microbial Fuel Cell: A bioelectrochemical system that convert wastes to Watts" published by Capital Publishing Company Ltd., New Delhi. In addition, a pilot plant has been commissioned at IIT Kharagpur under his guidance, which is a 10,000 L reactor for the continuous biohydrogen production from the organic wastes. The video has of the operation of the plant has been uploaded in the YOUTUBE and can be viewed at the link https://www.youtube.com/watch?v=MfoDj_VfIww

International Conference on Micro-Electronics, Electromagnetics and Telecommunications ICMEET 2017 on Sep 8-9, 2017 at Hyderabad
https://conferencealerts.com/show-event?id=182001

International Conference on Innovative Research in Mechanical, Material, Industrial, Automotive, Aeronautical and Nano-Technology (MIANT-2017) on Sep 9, 2017 at New Delhi
https://conferencealerts.com/show-event?id=188713

IOSRD- 24th International Conference on Recent Advances in Engineering, Technology and Science on Sep 22 to 23, 2017 at Hyderabad,
https://conferencealerts.com/show-event?id=189211

Engineering the Human Mind and the External World

V. V. S. Sarma

विश्वं दर्पणदृश्यमाननगरीतुल्यं निजान्तर्गतं
पश्यन्नात्मनि मायया बहिरिवोद्भूतं यथा निद्रया ।
यः साक्षात्कुरुते प्रबोधसमये स्वात्मानमेवाद्वयं
तस्मै श्रीगुरुमूर्तये नम इदं श्रीदक्षिणामूर्तये ।।

The universe is like the reflection of a city seen in the mirror of one's own inner being. This witnessing of the external world is happening within the Atman through the power of maya (माया) as of a dream in sleep. This is experienced directly at the moment of spiritual awakening within the non-dual realization of one's own Atman. Salutations to Him, the inner Guru, who causes this illumination of awareness, who is personified as Dakshinamurti

Adi Sankaracarya

Cogito ergo sum (I think, therefore I am) — René Descartes

तत्त्वमसि (tat tvam asi, That you are) — Chandogya Upanishad

Context

It is more than three years since Dr. Baldev Raj invited me to write an article for the INAE e-Newsletter. His premise was that the experiences of people who spent their productive lives in the engineering profession or as educators might inspire today's young engineers and students to take the challenges of their chosen profession of creating smarter systems, organizations, structures, processes and artefacts in a complex, dynamic, uncertain and even hostile world. Dr. Purnendu Ghosh reminded me of this invitation some time back. His mention of the title of the forth coming INAE book series, THE MIND OF AN ENGINEER incorporating these essays intrigued me. Is the mind of an engineer different from the mind of any other human being? Does a decade of training spanning the period of one's BE, ME and PhD programs affect the way a person thinks and acts? What does his experience teach him? I felt that introspection is certainly going to be instructive. It is said *"mana eva manushyanam karanam bandha mokshayoh"* (मन एव मनुष्याणां कारणं बन्धमोक्षयोः). The

ultimate source of all human endeavours is the mind and the purpose of engineering education is to train one to play the role of the designer of artefacts supposed to achieve specified goals or to serve some contingent purpose in a particular environment, say home, market place, factory or battle field. My interest in Artificial intelligence, an endeavour to build systems displaying human-like intelligence, makes the quotes in the beginning become part and parcel of my ideas on engineering. Where does the mind begin and end? What is its capability and limitation? What is its relation to intellect, consciousness, knowledge, psyche, self and soul on one hand and brain on the other? These have been questions continuing to bother humans since ancient times and still await complete understanding of the people working in diverse fields such as neuroscience, computer science, psychology, philosophy and religion. Brain is a physical material entity described with terms such as the grey and white matter. What is the ontological status of mind? The Sanskrit terms "*padam*" (पदं = word) and "*padartha*, (पदार्थ = meaning, denotation, category, matter etc.)" summarize the issue.

Beginning of the journey

Earth has made more than 20000 revolutions since I joined the BE program in Electrical Technology in the EE section of the Power Engineering Department at the Indian Institute of Science (IISc) after my BSc from Andhra University (AU). I heard of two famous names connected with the IISc, before joining there; of legendary CV Raman and his protégé and the Institute's then director, S. Bhagavantham, who was to become the first SA to RM (GoI). Both of them were earlier associated with Visakhapatnam and AU. I had to choose between the M. Sc. (Nuclear Physics) program at AU or the BE at IISc. My cousin PR Rao who did his M.Sc. (Physics) at AU then working in Bangalore recommended IISc to me. I also preferred Bangalore to Visakhapatnam, though I had no clear idea about the scope of engineering and its relation with science, mathematics and the human. I realized much later that this confusion was universal and I strongly disagreed with one erudite director of the IISc, who declared in an editorial in a science journal that science and engineering were the two sides of the same coin. Engineering, like any other creative activity, is just a virtual reality (VR) (e1, refer to end notes) world view of our inner being, just like science, philosophy or literature. This article is my journey down the memory lane in the world of engineering education.

Engineering – An ancient art

The words engine, engineer and engineering are related to a qualifying adjective "ingenious", its Latin root being *ingenerare*, which means "to create." God, the Creator, is obviously the first, the eternal and the best engineer creating and recreating the worlds (*lokas*) and the evolving beings inhabiting these worlds. Sri Krishna succinctly defined activities such as engineering as Yoga in his Bhagavad Gita (BG 2.50) as "*yogah karmasu kausalam*" (योग: कर्मसु कौशलम्). Action performed with skill and dedication is Yoga. The appropriate mind-set for action can also be achieved through Yoga. No wonder, the IIT at Kharagpur adopted this as its

motto. Yoga practice may be termed "control engineering" of human mind and consciousness and the very first sutra of Patanjali Yoga Sutras, says that Yoga stills the fluctuations of the conscious mind (*yogah cittavrtti nirodha*, योगश्चित्तवृत्तिनिरोधः) through techniques such as breath control. The relationship between body, breath, mind, knowledge and bliss is a well- discussed problem of Indian philosophy. According to Taittiriya Upanishad the soul is visualized within the body in the form of a miniature inch-man (अंगुष्ठमात्र पुरुषः) representing a soul (जीव) covered with five sheaths (कोशः) made of – food (अन्नं), breath (प्राणः), mind (मनस्), knowledge (विज्ञानं) and bliss (आनंदः) [e2].

God as creator is a transformation of an idea of creation (*samkalpa*, संकल्पः) arising of the attribute-less (*nirguna*, निर्गुण) Brahman dividing itself into Siva and Sakti or Purusha and Prakriti. This mutation is the starting point of creation. Theories of creation of *Darsana* literature involve a beginning, a transformation and an evolution, aptly described by Sanskrit terms such *Arambhavada* (आरंभवादः), *Parinamavada* (परिणामवादः) and *Vivartavada* (विवर्तवादः). God specifically as an engineer is represented in the Puranas by the divinity for architecture, Viswakarma (विश्वकर्मन्) and his Asura counterpart, Maya (मयः), the architect/engineer of the well-known palace Maya-Sabha in the Pandava Capital city, Indraprastha, identified with the modern city of Delhi in the Mahabharata. Asura Maya was also credited with the ancient Hindu Astronomy text "Surya Siddhanta" of Vedic Cosmology. Viswakarma was credited with many structures. He built the city of Lanka and the Pushpaka Vimana of Ravana in the Ramayana. Ancient civilizations (4000-1800 BCE) also boast of many civil engineering achievements. The Saraswati-Sindhu civilization, also known as the Harappan or the Indus valley civilization discovered in archaeological excavations is characterized by advanced town planning and water resources management applications. The sites such as Harappa (Punjab), Mohenjo-Daro (Sindh), Dholavira (Gujarat), Lothal (Gujarat) and Kalibangan (Rajasthan) are widespread in North West India up to Gandhara (modern Afghanistan) [1]. A recent (2007) paper in the Elsevier journal "Building and Environment" brings out elegantly the relationship between Hindu cosmology and the *vastu-purusha-mandala* (वास्तुपुरुषमंडल) in the 11th century Kandariya Mahadeva temple at Khajuraho, and explains the fractal geometry involved in the architectural design of the temple (Fig. 1) [2].

Fig 1 – Kandariya Mahadeva Temple, Khajuraho

The word "engine" in early English meant "to contrive". While military engineers worried about engines of war, the same principles are used by civil engineers (the term includes their mechanical, chemical, electrical, communication and aerospace counterparts) to design and operate the engineered artefacts in the service of the society. My own journey of half a century in engineering education was well within in the philosophical boundaries of civil and military engineering rather than in the development of a specific technology and its application in a single problem domain. In the Institute, my *alma mater* also, my own career as a teacher which commenced from the EE department (1967-73), went through ECE (1973-77) and settled in the School of Automation (now CSA) (1977-2012) and my 18 PhD students and 6 MSc (by research) students from time to time were drawn from CSA, ECE, Aerospace, Mathematics and Metallurgy departments and engineers from organizations such as IAF, NAL, ISRO, DRDO, BHEL under the external registration program. My working together with them closely was on defining, modelling, representing and solving problems arising in a specific context in a satisficing (meaning satisfy and suffice) manner. Teaching or research in my view is constant learning for the teacher even more than for the student.

From good, old fashioned Electrical Engineering to Cybernetics and Man-Machine Systems

After a colourful B Sc program, which gave us under the then new regulations, a strong dose of English literature, general education consisting of economics, history and politics along with science subjects, MP and C, the BE course appeared rather a dull, colourless, tasteless and out-dated affair. Among seemingly disconnected and assorted subjects such as applied

mathematics, applied mechanics, hydraulics, building construction, surveying, and machine tools in the first year, Electrical Circuit Theory was the only subject connected with the supposed main stream of study. While the Physics course of Electricity and Magnetism in BSc followed the historical route of electric charges, magnetometers, gold leaf electroscope, cells, solenoids and induction coils, Maxwell and Faraday, the EE course started with Ohm's and Kirchoff's laws, R, L, C circuits, voltage and current, both AC and DC. While the other courses generally followed British books, the lecturer of electrical engineering (who had an MS from Wisconsin) followed an American book, which had a better pedagogical approach. The lady, C. Lakshmibai, soon after earned the first Ph.D. awarded by the EE department of IISc. Even in our final year (1963-64) mostly vintage subjects such as electric traction, illumination, utilization, machines, wood pole and tower design and aspects of T&D of electric power were taught. Atkinson's Telephony and Gray's Electronics represented the electronics and communications part of the course. But changes were in the offing in the BE and ME programs of IISc by mid-sixties. The faculty of the department was much more research oriented than what the out dated BE program we went through, represented. The first head of EE, Alfred Hay's bridge circuit named after him and Yoganandam's method of current transformer testing (J of IEE, 1930) found their way into Golding's classic book on Electrical measurements in their time. From 1949 to late 1960s, the EE department's prized possession was an AC network analyser produced by GE. Before 1950, 30 such machines were in operation, 29 in USA and one at the IISc. All electricity boards in India simulated their power networks using it but this machine was out of bounds for students. The machine was a special-purpose analogue computer, used for power system analysis, power flow studies, short circuit calculations, and system stability studies till such machines were ultimately replaced by numerical solutions running on digital computers by 1980s. In 1958 IRE Transactions on Electronic computers published a paper on "A Novel Type of Isograph (Algebraic Equation Solver)" designed and built in the EE dept by P Venkata Rao and his student G Krishna, a special purpose analogue computer for accurate computation of roots of polynomials useful in analysing servomechanisms. Our own computing tool was a German made Aristo Studio slide rule.

By the time I joined ME (Power Systems) course in 1964, many visible changes have come into effect in the curriculum. Deekshatulu's PhD thesis in nonlinear control with many publications in Transactions AIEE (constituent of later IEEE) established that high quality research could be done in India itself. Srinath, a PhD from University of Illinois, taught us control theory. His use of Lee's book on Statistical Theory of Communication for the course on Advanced Control brought out the relation between Control and Communication. In ECE department Rideout and Rajaraman built a differential analyser and Ramakrishna studied relative efficiencies of Indian languages for Morse code. His mention of Panini's name made me curious. Names such as Wiener, Shannon, Bellman, Kalman, Nyquist, Pontryagin and Lyapunov became the new *Sapta Rishis* (Ursa Major, the Great Bear) on the control sky.

Components to Systems

From components such as motors, generators, transformers, towers and transmission lines we encountered in BE, the study of power system was a different ball game. A huge system of hundreds of generators spread over a vast geographical area and considerations such as load flow, load frequency control, stability and operational economics come into picture. The control and management problems get entangled. The problem of power system ever since had become major techno-management problem implying a fundamental reengineering of electric utility and service industry aimed at achieving a smart grid today. A smart grid is an evolving system which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, energy efficiency resources, electronic power conditioning, e-commerce and control of the production and distribution of electricity with high quality of service and dependability.

I realized that general systems, be they transmission, transportation, water resources or communication systems, they were all being studied using a single methodology. I joined as a PhD student working in control theory in 1966 under the supervision of Deekshatulu as a continuation of my ME project on power system control.

Deekshatulu asked me to work on Optimal Control Theory. Tou's book on Modern Control theory appeared just then with a chapter each on Calculus of Variations, Pontryagin's Maximum principle and Bellman's Dynamic Programming. They were like three formidable hills to be climbed and the literature looked like an intimidating forest. My guide had the stamina of a Bhagiratha to do exhaustive search on nonlinear control to come up with solvable problems with novel solutions to specific equations for his thesis but he himself was not much deeply involved in my topic. Luckily a text book on optimal control by Michael Athans from MIT appeared which evolved from his teaching of a course there. It contained many worked examples of optimal control and an exposition of the LQG (linear quadratic Gaussian) problem, showing that a linear control law derived from solving a Matrix Riccati equation as optimal with respect to energy-optimal quadratic criterion. With this work I was able to formulate some performance evaluation and sensitivity problems of optimal control. When the states are not measurable a state observer can be used to estimate the states from the input and output of the system. I was finding it difficult to conceive of some new problems. Thomas Kailath of Stanford was then spending his sabbatical year at the ECE dept of IISc. I attended his lectures on Wiener and Kalman filtering and on his advice I started work on stochastic optimal control and differential game problems and completed my thesis entitled "Some studies in optimal control with quadratic performance criteria". I did not like the title myself and I insisted my students that they should use titles that stress the main contribution of the thesis. Soon I had to find a problem and an approach for solving it for a research student who joined with me. I was awarded PhD degree in March 1971 and Mansoor Alam joined with me in Aug 1971 and I decided that I would give a well-defined problem to him for research rather than suggesting an area of work as in our time.

We had a nice system then working at the IISc library. All the new journals received in the week were displayed in a hall on Friday evening. It has become a habit to me, learnt from my guide, which continued for a long time, of spending few hours in the library at that hour browsing through the new journals. Till my PhD was over I was mostly referring to journals in Control theory such as IEEE Trans Automatic Control, International Journal of Control, Proc. IEE, J of Basic Engineering (ASME) and Automatica. After getting the degree, I was curious about the content of Management Science, Operations Research and other engineering and economics subjects. The terms control, manage and govern sounded similar to my ears. I located some papers dealing with machine maintenance, formulated and solved as optimal control problems, written by two American Professors from management schools at Carnegie Mellon and North-Western. The models were simple and the deterministic control theory they used was elementary. I was better equipped to use advanced control theory. I showed these papers to my student and told him that we can develop a unified theory, also taking into account the uncertainty in the system. We could formulate and solve the problem in a very short time. We wrote a paper and submitted the same to Management Science. The reply was prompt saying that our style of presentation was nearer to engineering than to management science and we were advised to submit the paper to an engineering journal. We sent it to the new IEEE Transactions on Systems, Man and Cybernetics. It was accepted as full paper in the first review. The model was generalized considerably soon using Markov and semi-Markov decision models and papers in IEEE transactions on SMC, Reliability, Automatic Control, International general of Systems Science followed. Alam submitted his thesis in July 1974 with more than 8 excellent publications. The work got him post-doctoral fellowships in UK and Canada in sequence and he is now a Professor and Chair of EECS in University of Toledo, OH, USA. In 1974 AK Rao of aerospace department saw the reports on this thesis in Senate proceedings and inquired me if our methods can be used to study the maintenance problems of aircraft. An air force engineer who completed his ME in Aeronautical Engineering would be able to register for PhD and we could bid for a DRDO (ARDB) project to support the work.

After hours of discussions with the student Ramchand (I should call them domain knowledge elicitation sessions now) on maintenance problems of IAF aircraft and after visits to the flying stations and repair depots, I had an emerging mental picture of the issues at hand. The availability of a small fleet of aircraft in a flying-base, repair-depot combination was modelled and studied. A cyclic queue model showed the effect of the principal uncertainties in operation and repair and the consequent decrease in the availability of aircraft at the flying-base. This was published in IEEE Reliability. Queuing models were not unfamiliar to me. We encountered them in design of automatic telephone exchanges and they were developed by a Danish telephone engineer Erlang much earlier. We had seen some applications of cyclic queues in a Civil Engineering journal in an application concerned with earth moving. We adopted that model for our study. The perennial problem of resource allocation for fleet and facility build up that faces planners was modelled and solved as an optimal control problem.

These models contain two "policy" variables representing investments in aircraft and maintenance/repair facilities. Interactions of major activities involved in air fleet operations, maintenance, and logistics were investigated in the framework of closed queuing networks with finite number of customers. An interesting by-product of this work is the use of spectrometric oil analysis program (SOAP) data from the Rolls Royce Gnome Engines of Westland Sea King helicopters of Indian Navy. I was told that Navy was sending SOAP data samples to London for engine maintenance decisions. We developed a decision theoretic model for health monitoring which was published in the AIAA Journal of Aircraft. Several papers in IEEE Transactions of SMC, Reliability and Simulation journals resulted from these studies. The reviewer of the thesis, Andrew Sage of Southern Methodist University (who was also the chief editor of the IEEE Trans SMC) wrote "the thesis was the best I had seen in recent years". The IAF officer later rose to be the Director of a DRDO laboratory, CABS (Centre for Air Borne Systems) and Mani, the project assistant subsequently became a Professor in Aerospace Engineering at IISc. My ideas on Systems Engineering as distinct from device technologies thus found their initial successes. Pedar from Electronics division of NAL joined for PhD and his lab director, SR Valluri, wanted him to work on aerospace electronics. We discovered that the trend was fly-by-wire (FBW) aircraft. FBW system replaces the conventional manual flight controls of an aircraft with an electronic interface. The movements of flight controls are converted to electronic signals transmitted by wires and flight control computers determine how to move the actuators at each control surface to provide the desired response. The FBW system also allows signals sent by the aircraft's computers to automatically perform control functions without the pilot's input, as in systems that automatically help stabilize the aircraft, or prevent unsafe operation of the aircraft outside of its performance envelope.

The aircraft computer is to be an ultra-reliability system and design of such Fault- tolerant systems was a special area in Computers on which IEEE transactions on computers was publishing special issues regularly. Pedar's work brought out the concept of phased mission analysis of aircraft flight and the architecture optimization of aerospace computer systems. The first paper from the study was published in IEEE Trans on Reliability and the second one was in IEEE Transactions on Computers. The later paper was republished by IEEE as a benchmark paper in the area of hard real-time systems. Pedar later spent some time in NASA labs as a guest scientist. Ramana from ISRO used queuing models for slotted ALOHA satellite channels. He then moved to INMARSAT (maritime satellite organization), London. His results appeared in Proc. IEE (London) and IEEE Trans AC. Ramanjaneyulu (Ram Chakka), who worked for his M.Sc (by research) with me, proposed a model for server unreliability in closed queuing networks. Breakdowns and repairs of servers, assumed to be time-dependent, are modelled using virtual customers and virtual servers in the system. The problem is thus converted into a closed queue with all reliable servers and pre-emptive resume priority centres. The results were published in IEEE reliability 1989. He later completed his Ph D in University of New Castle

UK and continued his excellent work in the same area and is a Professor of Computer Science, and Director of Research at MIET, Meerut now.

With my friends Viswanadham (IISc) and MG Singh of UMIST (UK) we completed a research monograph on "Reliability of Computer and Control Systems" published by North Holland in 1987. Viswanadham distinguished himself later as professor researching in Logistics and Manufacturing at ISB, Hyderabad and NUS, Singapore after voluntary retirement from IISc. Kanchana of CABS (DRDO) in the year 2000 did work on Software quality and dependability issues for the airborne surveillance platform. She used Taguchi methods of experiment design for software quality enhancement.

Move towards PR and AI

Deekshatulu, after his sabbatical at IBM Watson Centre and the Environmental Research Lab (formerly, Willow Run Lab) at the university of Michigan, brought back ideas on subjects such as pattern recognition (PR), picture processing and remote sensing and started courses on such subjects. Around 1976 Deekshatulu left IISc to become director of NRSA Hyderabad where he played a key role in the popularization of remote sensing technology in India.

In the meantime my association with ECE department opened new horizons and also introduced constraints. The mind-set in ECE was a frequency based division of the universe. I had begun to look at signals along with systems that communicate them. Audio, Radio and TV and Microwave along with Tube electronics and transistor electronics were the faculty groupings. Colleague and friend, Yegnanarayana's effort led to the development of an acoustics lab with anechoic and reverberation chambers. He is presently among our top-notch speech scientists now associated with BITS, Hyderabad after superannuation from IIT Madras and later at IIIT, Hyderabad. Speech signal processing and speech recognition were then being talked about. Atal, an alumnus of ECE, working in Bell Labs came out with the linear predicting coding of speech. Atal's LPC scheme was, in fact, the discrete form of Wiener filtering.

In ECE, I used to teach Statistical theory of communication and Detection, Estimation and Modulation. I was also the first to teach a digital signal processing (DSP) course in IISc. With my control background and familiarity with Z-transform in sampled data control systems, DST posed no problems. Speech signal interested me. Languages developed as speech and writing was a much later affair. The phoneme set (varnamala, वर्णमाला) of Sanskrit perfectly matches with the speech production system of a human being (the vocal tract). Speech can be used for a variety of PR problems. Henry Dante worked with me on Speaker recognition. With the limited facility of digitization of speech available on a HP Fourier analyser we demonstrated accurate speaker identification for a set of hundred speakers. The 1979 papers on "Automatic speaker identification for a large population" were published in Acustica and IEEE Trans on Acoustics, Speech and Signal Processing. A paper entitled "A pattern recognition model of

voice-based personal verification systems for forensic applications" appeared in IEEE SMC in 1980. I now see that ICICI bank and SBI are introducing "voice-banking" in India.

"Divide and conquer" was an age old problem solving paradigm, and it is considered a "weak" or "narrow" AI method. In stochastic control it takes the form of separation theorem. The estimation (or filtering) problem and the feedback control problem are solved separately. In PR the separation is between feature extraction and classification. In statistical PR with two classes, the classification problem is the binary hypothesis testing problem of statistics or the detection problem of communication. In medical diagnosis features or test results have associated costs and risks. My student Dattatreya looked at the problem of medical diagnosis as a hierarchical PR problem .and his work with deterministic costs was published in IEEE Trans on Pattern Analysis and Machine Intelligence. He extended it to stochastic costs in a Trans SMC paper. Dattatreya was a professor at University of Texas at Dallas for two decades and is now a principal scientist in MITRE Corporation, an exclusive Systems Engineering and IT consultant firm for the US government. Bharathi Devi worked on Fuzzy pattern recognition and our IEEE Transactions SMC paper on "Fuzzy Clustering" was republished in a later benchmark paper volume

In 1983 I visited my Guru Maha Mahopadhyaya Dr. K. Sivananda Murty at Warangal, a well-known Vedic scholar and Yogi. His interpretation of Kathopanishad in the light of Yoga Sastra is my reference text for Hindu philosophical issues touched in this essay. He suggested that I should look at Artificial Intelligence (AI) as an area for my further research work. In 1984 I went on sabbatical leave to the Centre for Advanced Computer Studies, University of South-western Louisiana (USL, now University of Louisiana at Lafayette). I started to teach AI at USL. AI was also called MI (machine intelligence) and the term artificial (meaning made in imitation) seemed to convey a negative connotation. Designing machines exhibiting human-like intelligence and smartness was the goal here. We encounter the philosophical questions of the mind-body problem, human rationality, logic, information and knowledge and consciousness issues and AI has strong interfaces with philosophy and psychology. In psychology computers provided an analogy for the mind-brain system I realized that AI books talk only of Aristotle and Greek Logic. The much deeper Indian contributions to logic, language and human mind find inadequate mention in the Computer Science literature. Very few have heard of Akshapada Gautama of yore or more recent (12 -18 century CE) contributions of logicians of Mithila and Navadvipa such as Gangesa Upadhyaya and Raghunatha Tarka Siromani. While the Western logicians were still in the Aristotelian frame of mind, in Navadvipa (Nadia Dist, WB), the Navya Nyaya School of logic reached its peak. In modern times BK Matilal (Kolkata and Oxford), NS Ramanuja Tathachar (Tirupati) and P Sriramachandrudu (Hyderabad) excelled in Darsanas. At least I had the good fortune of meeting the latter two of them. While my thoughts were on the philosophy of AI, my students were working on engineering aspects of AI and incorporation of AI ideas in Systems design.

Computer scientists have already recognized the contributions of Sanskrit grammarians such as Panini, Patanjali and Bhartrhari to the study of generative grammars of languages. In computer science, BNF (Backus Normal Form or Backus–Naur Form) is one of the two main notation techniques for context-free grammars, often used to describe the syntax of languages used in computing, such as programming languages and drew inspiration from Sutras of Panini. Noam Chomsky undoubtedly derived inspiration from Panini. In fact there was some discussion in IEEE to name BNF as Panini-Backus form. This created in me an interest in Indian logic (nyaya, न्यायः and associated tarka, तर्कः) and its possible use in IT. My first encounter with India Logic was in an Encyclopaedia of Logic I saw it in the USL library and my first expository paper entitled "A survey of Indian Logic from the point of view of Computer Science" was in Sadhana (1994). A more recent one which touches Navya-Nyaya relations is in JNU's annual manual on Sanskrit Studies [4].

Computers and the Sciences of the Artificial

Cybernetics, which was defined as the science of control and communication in the animal and the machine by Norbert Wiener way back in 1948, later was defined by many variously as experimental epistemology concerned with the communication within an observer and between the observer and his environment (McCulloch) and science of effective organization (Stafford Beer) focussing on form, pattern, and metaphors of behaviours rather than on specific things. In the twentieth century the human being has become an integral part of the engineering system design. Human-Machine systems have become the order of the day. Design of an aircraft with a human pilot in the cockpit assisted by smart "phantom" flight crew makes the human being a subsystem rather than an external operator or the designer of the system. Mind, intellect and consciousness, the internal instruments (अन्तःकरण) of a human, in some form have to become a part of the engineered system as neuro-system models. Neuroscientists study how different neural circuits analyse sensory information, form perceptions of the external world, make decisions, and execute movements.

Over the last several decades, Cybernetics has evolved as a trans-disciplinary approach for studying self-organizing and regulatory systems. Today Cyber-Physical Systems consisting of collaborating computational elements controlling physical entities and systems are contemplated in areas as diverse as aerospace, automotive, chemical processes, civil infrastructure, energy, healthcare, manufacturing, transportation, entertainment, and consumer appliances. Social engineering and Political Engineering are meaningful terms for an engineer today. Easley and Kleinberg talk of reasoning methods in a highly connected society in their book "Networks, Crowds and Markets". Black money flows, money laundering, correlation of real estate business and general elections with cement factory production can all be modelled and studied using this basis. I wrote some introductory articles on these network topics in newspapers and magazines.

The term "artificial intelligence" was the brainchild of the Noble laureate (in Economics), Herbert Simon. In his classic work "The Sciences of the Artificial" [3] he observes "The world we live in today is much more human-made, or artificial, world than it is a natural world. Almost every element in our environment shows evidence of human artifice." He adds that a computer as part of a system makes it smart. This immediately raises the questions "Can machines think? Are they capable of rational behaviour? Do they display consciousness, sentience and conscience of some form?" The observation is that both the brain-mind system and the digital computer are information processing systems. At the first level, Simon introduces heuristic search, where brute force search is replaced by "search and reason" approach as a first thinking task solvable by computers in imitation of human intelligence. Simon observes that the most characteristic cognitive skill of human beings is the use of language. The key observation of Simon is "While the computer is embodied in hardware, its soul is a program." The similarity is that both work on symbol strings. A computer can provide a model for brain-mind system (an aspect of the mind-body problem) in specific intelligent tasks, such as playing games and solving puzzles. How far can "the emperor's new mind"(e3) go, or is it similar to "the emperor's new clothes"?

Our AI based work

I asked my student Sunil Noronha to look at project management problems from the point of view of AI. The project evaluation and review technique (PERT) is well known. Normally such planning work is done before the project and date of initiation and PDC are given. But if there are delays as usual in the completion of activities and costs, The PERT chart does not help in on-line monitoring. There are lot of uncertainties in the information and knowledge available when the project is initially planned. Noronha developed an intelligent decision support system using imprecise information and knowledge structures called project influence graphs combining the power of PERT networks, influence diagrams and Petri nets. Our 1991 survey paper in a special issue on AI in management with some new material in IEEE Transactions on Knowledge and Data Engineering entitled "Knowledge-based approaches for scheduling problems: A survey" was widely cited. Our joy knew no bounds when we saw the paper entitled "Artificial intelligence: where has it been, and where is it going?" by Herbert Simon, father of AI, in the same issue, preceding our paper. With an Iranian student, Mohsen Moshkenani, I did some interesting work on a less studied problem in expert systems. In his thesis "Knowledge teaching: An alternative strategy for knowledge-base (KB) development" we looked at the knowledge acquisition bottleneck in expert systems. In traditional systems a domain expert is constrained by the structures imposed by the knowledge engineer. In our scheme the computer is modelled as a student and the domain expert as a teacher with or without the intermediary of a knowledge engineer. All that can be expressed in a language by the teacher should find a place in the KB. We looked at dimensions of knowledge, knowledge types, whether knowledge is fully expressible in language, gaps and inconsistencies in knowledge, truth and its degrees and designed an interactive system for knowledge teaching where the domain expert is a teacher and the program a student. In retrospect, today I would

apply Indian logic for testing the veridicality (degree of truth) of proposition. AI can handle only belief systems. Truth is only tentative and is a matter of degree. Language is always ambiguous. Knowledge coexists with ignorance in any human being. Knowledge, which is a created product of the mind, is always specified in relation with awareness of human beings. A proposition in Plato's dialogues views "knowledge as justified true belief". If we consider the proposition "Sun rises in the East", it is true for an observer on the Earth. For a traveller in space it has no meaning. A proposition justified true on the basis of sensory perception also need not be absolutely true. Thus means of arriving at correct knowledge (प्रमाण), thing to be studied (प्रमेय) and doubt or uncertainty (संशयः) are the first three categories of Indian logic according to the first aphorism of Gautama. Thesis of N Srinivas (1996) dealt with uncertainty handling in KBS (Knowledge-Based Systems) and Mohanvelu proposed expert systems for frequency management in ISRO. Another student Suresh Babu from BHEL worked on PROLOG technology for temporal reasoning in relational databases

Vijay Rao from DRDO worked on quantitative software lifecycle modelling. An evolutionary process taking place in engineering systems is the shift from hardware to software and the role of software engineering is becoming more central. This shift represents a trend from a piece-meal vision of software development to a holistic, system-wide vision. The term "software crisis" of 1960's and 1970's was the observation that most software development projects end up with massive cost overruns and schedule delays. The growing complexity of software projects led to Waterfall, Spiral and other qualitative models to depict the software development lifecycle. We developed a generic, unified lifecycle model (ULM) integrating the product, process and project view of software development based on re-entrant lines, which are multi-class queueing networks. The techniques also included fuzzy and rough set concepts. Some of this work was recently published in 2014 Springer monograph on "Innovations in Intelligent Machines – 5 (Computational Intelligence in Control Systems Engineering (Ed: Valentina Balas)).

R Ravi's 2005 thesis is entitled "Intelligent Knowledge Based System for Hot Forging Process Design". Ravi worked with me and a physical metallurgist Y Prasad for his Ph D in CSA department on expert systems for metallurgy. In any bulk metal working process, designing the process for forging is strongly dependent on human expertise, intuition, and creativity, and is an iterative procedure involving extensive and time consuming experimental work. A logical choice for realizing such a complex system is a hybrid intelligent system, consisting of an intelligent knowledge-based expert system and artificial neural network models. Ravi's thesis implements such a system resulting in considerable lead time and cost reduction. Ravi is a Principal Research Scientist in Material Engineering at IISc now.

The last student who got PhD under my supervision in 2012 was Indra from ISTRAC/ISRO. Her thesis dealt with the architecture design of next generation smart satellites. Presently, most spacecraft are controlled from ground, which involves activities such as up-linking the daily operations schedule and monitoring the health parameters. Advanced space exploration

systems demand intelligent autonomous spacecraft, which exhibit goal-directed and adaptive behaviour. An autonomy framework is defined with a six level structure comprising of the following capabilities - reflex, awareness, self-regulation, self-healing, self-adaptation and self-evolution. The last mentioned three theses were really engineering applications of AI.

Post-Superannuation (2006 – 2016)

IISc and INAE supported me during 2006-2012 as honorary professor and distinguished professor respectively. I was able to study my favourite subject of interface between intelligent systems in engineering and Indian Philosophy. I have now greater appreciation of the four Darsanas: Samkhya, Yoga, Nyaya, Vaiseshika and some familiarity with Mimamsa and Vedanta. For exploring the limits of AI and smart systems on the one hand and for exploring the function of human mind in terms of thinking, memory, discrimination (viveka, विवेकः) , knowledge, ignorance (अविद्या), consciousness, self, Atman and Brahman (as defined by *satyam jnanam anantam brahma*, सत्यं ज्ञानं अनन्तं ब्रह्म). Indian philosophy has the potential of clarifying the scope of AI and its boundaries. One of hobbies in this period is writing articles for general public in Telugu and English on topics of Indian philosophy, history, and society for some magazines and newspapers. Smart technology today has tremendous influence on the society. The impact of social networks such as Twitter and Facebook is one such example.

Studies by engineers can influence subjects such as history. Evidence combination methods of AI can check and question the credibility of historical narratives, particularly in the context of Indian history, where evidence from multiple sources is to be combined to get credible narratives. A less credible alternative is presented as a historical fact, such as the so called Aryan Invasion of India. Arun Shourie, an economist by training, could rightly question Indian historiography as the title of his book indicates (e7).

Ethics for AI systems

Ethics involves systematizing and recommending concepts of right and wrong conduct of humans living in a civilized society. In earlier days when it was called moral philosophy, religion and culture used to provide guidelines for acceptable social behaviour for humans by prescribing do's and don'ts. As societies become industrialized and as high technology becomes part of human life, many new ethical problems arise which need to be addressed by system designers and regulatory authorities. In the modern world, humans are constrained to coexist with artificial entities created by law such as organizations, companies and regulators on one hand and technological entities such as robots, driver-less autonomous vehicles, drones and even ubiquitous entities such as smart phone and i-pads interlinked to an Internet of Things (IoT). Laws, Regulations and Ethics are not keeping pace with the rapidly emerging new technologies such as AI.

Few examples where AI appears are sufficient to note its spread and widespread usage: ubiquitous computing, smart phones, mobile apps, mobile internet, Big data, social networks, autonomous vehicles (AV) and near AV, drones, internet of things, clouds, cyber physical systems (robotics) and smart cities. The ethics of artificial intelligence is the part of the ethics of technology specific to robots and other artificially intelligent agents and beings. Each domain listed above raises its own ethical concerns. While all the areas listed above have in the background AI programs, Intelligent Agents, Knowledge Bases, smart materials and subsystems, the regulatory policy and ethics have to be considered domain- wise. For example, what happens when a self-driving car has a software failure and hits a pedestrian, or a drone's camera happens to capture images of persons in a private swimming pool or an autonomous robot injures or kills a human? Contemporary ethical concerns about social networking services are privacy, the ethics of identity and community, friendship and values, democracy, freedom of speech and cybercrime. Recent discussions with members of a study group of ITU=ATP forum are summarized in this report [5].

Inner hierarchical structure of mind

Human mind is defined in Western literature as the set of cognitive faculties that enable sentience, consciousness, perception, thinking, judgement, and memory. All these faculties constitute human intelligence. An intelligent engineering system on similar lines will have a perceptual system (sensors), a memory system, a processing system, a motor system (actuators), and so on. There is a need to consider knowledge and its representation. Is this knowledge trustworthy? There is a distinction between knowledge and belief and knowledge is the set of certified true beliefs. In view of the acceptability or otherwise of the certification process we may assume that AI deals with only belief systems. This is the view of Allen Newell in his paper "The Knowledge Level" (e4). There is a school which believes in brain-mind identity. Consciousness levels – Wake Up, Dream, Sleep, Anaesthesia and Coma consciousness are described with the body. Freud talked of id, conscious and subconscious levels. Jung distinguished between psyche and self. By psyche, he meant the totality of all psychic processes, conscious as well as unconscious. He defined self as a clearly demarcated functional complex that can best be described as a "personality".

Indian philosophy proposes a distinct inner hierarchical structure in the mind. At the lowest level mind (manas, मनस्) is felt only when there is thought. Mind manifests as thought. Thoughts arise when the sense organs make contact with the sense-objects. This contact is reported to the intellect (buddhi, बुद्धिः). Intellect consists in the use of discretion or discrimination taking place on the basis of past experiences known as memory (smriti, स्मृतिः). Memory spans everything in the past extending from the previous instant to remote past extending even to previous lives. Intellect projects its judgment or decision on to the consciousness (citta, चित्त) which is an impersonal non-discriminating reflector like a mirror. It is citta that propels the person (in fact, the core inner actor characterizing him) to action, right

or wrong (karma, कर्मन्). It is this action (karma) which binds the actor or the doer to its chain of consequences. It is the actor that is called ego (ahamkara, अहङ्कार) or self (jiva, जीव). If citta through spiritual practice stops reflecting the intellect and is turned towards the ego, jiva becomes free of the separating consciousness and the jivatva is lost and the identifying tendency with respect to the body is lost. This is self-realization or being God (tat tvam asi). In the quote "I think, therefore I am" the first I is manas and buddhi and the second I is ego. In short, in the terminology of intelligent agents "the mind (manas) is the servant, buddhi is the reporter, citta is the observer and the ahamkara is the actor or owner. Indian logic is the logic of relations and the location-located relation is an important one. In this terminology, consciousness is the location of ego, which is what "I am conscious that I exist" means. This explanation clarifies the notion of mind considerably (e5). Stephen Phillips presented a paper on "The Mind-Body Problem in Three Indian Philosophies, Sankara's Advaita Vedanta, Gangesa's Navya Nyaya, and Aurobindo's Theistic Monism" at IIT Khargapur in 2002 and there is need for exploring this by AI researchers in India (e6).

Concluding Remark

It is true that the smartness of machines is increasing at a high rate. Can a machine be ever made to reach the intelligence level of "the man who knew infinity"? Can quantum computers model brain functions or mental activities? Can "strong AI" (a machine with consciousness, sentience and mind) or "artificial general intelligence" (a machine with the ability to apply intelligence to any problem, rather than just one specific problem) realized in the near future. Probably the new generation researchers think about such things. A mental picture or thought is the specification of a future artefact. As it happens engineering always falls short of perfection and science always false short of truth.

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End notes

(e1) Virtual Reality (VR), is multimedia experience of computer-simulated life projecting an environment that simulates physical presence in places in the real world or imagined worlds and lets the user interact in that world. Virtual reality artificially creates sensory experiences, which can include sight, hearing, touch, smell, and taste. Acarya Sankara says that the so called the ephemeral real world is also such an illusory vision of human consciousness.

(e2) Sivananda Murty, in his classic work "Katha Yoga", (Aditya Prakashan, New Delhi, 2009) gives an interpretation of Kathopanishad from the point of view of yoga. He explains the 5 sheaths of the inner man (the self) of anna, prana, manas, vijnana and ananda .

(e3) The Emperor's New Mind: Concerning Computers, Minds and The Laws of Physics is a 1990 book by mathematical physicist Sir Roger Penrose. Penrose argues that human consciousness is non-algorithmic, and thus is not capable of being modelled by a conventional Turing machine-type of digital computer. Penrose hypothesizes that quantum mechanics plays an essential role in the understanding of human consciousness. This makes it closer to the Jaina logic of syadvada.

(e4) Allen Newell was among the pioneers of AI at CMU along with Herb Simon. This is from discussion in "Philosophical frameworks for understanding Information systems", 2007, IGI Publishing, Hershey, New York, (Ed) Andrew Basten, on Allen Newell's paper on The Knowledge Level.

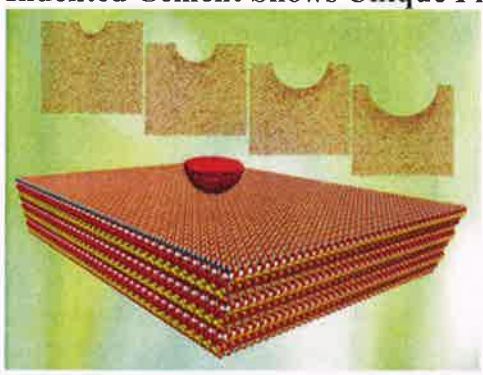
(e5) From unpublished lecture notes of MM K. Sivananda Murty

(e6) Infinity Foundation of Rajeev Malhotra was one of the sponsors of the International Multi-disciplinary Conference on Mind and Consciousness during January 9-11, 2002, IIT Kharagpur and on his initiative Stephen Philips, professor of philosophy at U Texas, Austin presented this paper. Philips studied Navya Nyaya with Ramanuja Tatacharya of Rashtriya Sanskrita Vidya Peeth, Tirupati.

(e7) Arun Shourie, 1998, Eminent Historians: Their Techniques, Their Line, Their Fraud

Civil Engineering

1. Indented Cement Shows Unique Properties



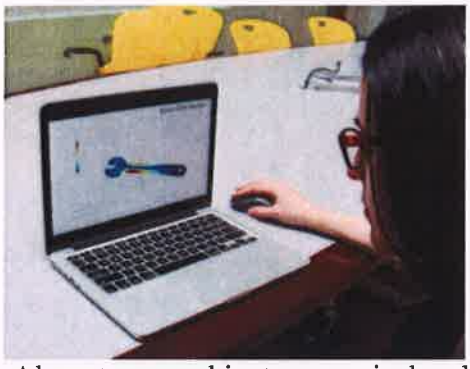
Indented tobermorite, a natural analog to the calcium-silicate-hydrate mix in cement, responds differently than bulk tobermorite, depending on the size of the indentation and the force. Layers that bond through indentation remain that way after the force is removed, according to Rice University engineers.

Rice University scientists have determined that no matter how large or small a piece of tobermorite is, it will respond to loading forces in precisely the same way. But poking it with a sharp point will change its strength. Tobermorite is a naturally occurring crystalline analog to the calcium-silicate-hydrate (C-S-H) that makes up cement, which in turn binds concrete, the world's most-used material. A form of tobermorite used by ancient Romans is believed to be a key to the legendary strength of their undersea concrete structures. The finely layered material will deform in different ways depending on how standard forces -- shear, compression and tension -- are applied, but the deformation will be consistent among sample sizes, according to Rice materials scientist Rouzbeh Shahsavari. For their latest survey, Shahsavari built molecular dynamics models of the material. Their simulations revealed three key molecular mechanisms at work in tobermorite that are also likely responsible for the strength of C-S-H and other layered materials. One is a mechanism of displacement in which atoms under stress move collectively as they try to stay in equilibrium. Another is a diffusive mechanism in which atoms move more chaotically. They found that the material maintains its structural integrity best under shear, and less so under compressive and then tensile loading. More interesting to the researchers was the third mechanism, by which bonds between the layers were formed when pressing a nanoindenter into the material. A nanoindenter is a device used to test the hardness of very small volumes of materials. The high stress at the point of indentation prompted local phase transformations in which the crystalline structure of the material deformed and created strong bonds between the layers, a phenomenon not observed under standard forces. The strength of the bond depended on both the amount of force and, unlike the macroscale stressors, the size of the tip. "There is significant stress right below the small tip of the nanoindenter," Shahsavari said. "That connects the neighbouring layers. Once you remove the tip, the structure does not go back to the original configuration. That's important: These transformations are irreversible. "Besides providing fundamental understanding on key deformation mechanisms, this work uncovers the true mechanical response of the system under small localized (versus conventional) loads, such as nanoindentation," he said. "If changing the tip size (and thus the internal topology) is going to alter the mechanics -- for example, make the material stronger -- then one might use this feature to better design the system for particular localized loads." Shahsavari is an assistant professor of civil and environmental engineering and of materials science and nanoengineering.

Source https://www.sciencedaily.com/releases/2017/07/170719173712.htm

Computer Engineering and Information Technology

1. Reshaping Computer-Aided Design



Adriana Schulz, an MIT PhD student in the Computer Science and Artificial Intelligence Laboratory, demonstrates the InstantCAD computer-aided-design-optimizing interface.

Almost every object we use is developed with computer-aided design (CAD). Ironically, while CAD programs are good for creating designs, using them is actually very difficult and time-consuming if you're trying to improve an existing design to make the most optimal product. Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and Columbia University are trying to make the process faster and easier: In a new paper, they've developed InstantCAD, a tool that lets designers interactively edit, improve, and optimize CAD models using a more streamlined and intuitive workflow. InstantCAD integrates seamlessly with existing CAD programs as a plug-in, meaning that designers don't have to learn new tools to use it. "From more ergonomic desks to higher-performance cars, this is really about creating better products in less time," says Department of Electrical Engineering and Computer Science PhD student and lead author Adriana Schulz. "We think this could be a real game changer for automakers and other companies that want to be able to test and improve complex designs in a matter of seconds to minutes, instead of hours to days." Traditional CAD systems are "parametric," which means that when engineers design models, they can change properties like shape and size ("parameters") based on different priorities. For example, when designing a wind turbine you might have to make trade-offs between how much airflow you can get versus how much energy it will generate. However, it can be difficult to determine the absolute best design for what you want your object to do, because there are many different options for modifying the design. On top of that, the process is time-consuming because changing a single property means having to wait to regenerate the new design, run a simulation, see the result, and then figure out what to do next. With InstantCAD, the process of improving and optimizing the design can be done in real-time, saving engineers days or weeks. After an object is designed in a commercial CAD program, it is sent to a cloud platform where multiple geometric evaluations and simulations are run at the same time. With this precomputed data, you can instantly improve and optimize the design in two ways. With "interactive exploration," a user interface provides real-time feedback on how design changes will affect performance, like how the shape of a plane wing impacts air pressure distribution. With "automatic optimization," you simply tell the system to give you a design with specific characteristics, like a drone that's as lightweight as possible while still being able to carry the maximum amount of weight. The reason it's hard to optimize an object's design is because of the massive size of the design space (the number of possible design options). "It's too data-intensive to compute every single point, so we have to come up with a way to predict any point in this space from just a small number of sampled data points," says Schulz. "This is called 'interpolation,' and our key technical contribution is a new algorithm we developed to take these samples and estimate points in the space." A researcher says InstantCAD could be particularly helpful for more intricate designs for objects like cars, planes, and robots, particularly for industries like car manufacturing that care a lot about squeezing every little bit of performance out of a product. "Our system doesn't just save you time for changing designs, but has the potential to dramatically improve the quality of the products themselves," says a researcher. "The more complex your design gets, the more important this kind of a tool can be." Because of the system's productivity boosts and CAD integration, Schulz is confident that it will have immediate applications for industry. Down the line, she hopes that InstantCAD can also help lower the barrier for entry for casual users. "In a world where 3-D printing and industrial robotics are making manufacturing more accessible, we need systems that make the actual design process more accessible, too," Schulz says. "With systems like this that make it easier to customize objects to meet your specific needs, we hope to be paving the way to a new age of personal manufacturing and DIY design."

Source https://www.sciencedaily.com/releases/2017/07/170724172557.htm

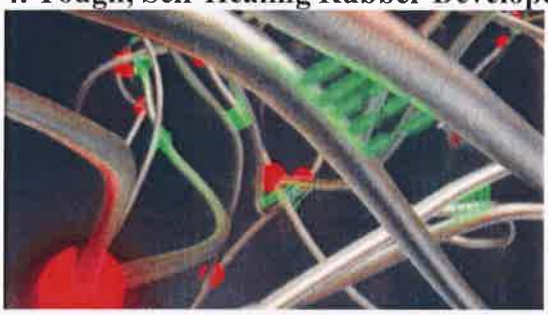
3. Graphene-Like Materials Printed with Inkjet Printer

Researchers team has developed inks made of graphene-like materials for inkjet printing. New black phosphorous inks are compatible with conventional inkjet printing techniques for optoelectronics and photonics.

An international research team has developed inks made of graphene-like materials for inkjet printing. New black phosphorus inks are compatible with conventional inkjet printing techniques for optoelectronics and photonics. Since the discovery of the Nobel Prize winning material graphene, many new nanomaterials promise to deliver exciting new photonic and optoelectronic technologies. Black phosphorus is a particularly interesting post-graphene nanomaterial for next generation photonic and optoelectronic devices. Yet despite remarkable performance in the lab, practical real-world exploitation of this material has been hindered by complex material fabrication and its poor environmental stability. "Our inkjet printing demonstration makes possible for the first time the scalable mass fabrication of black phosphorus based photonic and optoelectronic devices with long-term stability necessary for a wide range of industrial applications," tells Professor Zhipei Sun at Aalto University in Finland. Scientists optimized the chemical composition to achieve a stable ink through the balance of complex and competing fluidic effects. This enabled the production of new functional photonic and optoelectronic devices by inkjet printing with excellent print quality and uniformity -- just like the printing of intricate graphics or photographs on paper. The researchers' work demonstrated the benefits of their novel technique by inkjet printing devices that take advantage of the properties of black phosphorus, not least its semiconducting bandgap that can be readily varied by engineering the number of atomic layers and can cover the visible and near-infrared region of the electromagnetic spectrum. The researchers also demonstrated printed black phosphorus based nonlinear optical devices that can be easily inserted into lasers to act as ultra-quick optical shutters, converting a continuous beam of laser radiation into a repetitive series of very short bursts of light suited for industrial and medical applications, such as machining, imaging and sensing. In the study, black phosphorus was also able to act as an efficient and highly-responsive detector of light, extending the wavelength range over which conventional silicon-based photodetectors can operate. Importantly, the researchers showed that the black phosphorus ink can be seamlessly integrated with existing complementary metal-oxide-semiconductor (CMOS) technologies, while the inkjet printing technique developed offering the prospect of supporting the fabrication of so-called heterostructured materials that aim to capitalize on the benefits of distinct, yet complementary properties of multiple nanomaterial layers through controlled fabrication.

Source https://www.sciencedaily.com/releases/2017/08/170817110907.htm

4. Tough, Self-Healing Rubber Developed



Self-healing rubber links permanent covalent bonds (red) with reversible hydrogen bonds (green).

Imagine a tyre that could heal after being punctured or a rubber band that never snapped. Researchers from the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) have developed a new type of rubber that is as tough as natural rubber but can also self-heal. Self-healing materials aren't new -- researchers at SEAS have developed self-healing hydrogels, which rely on water to incorporate reversible bonds that can promote healing. However, engineering self-healing properties in dry materials -- such as rubber -- has proven more challenging. That is because rubber is made of polymers often connected by permanent, covalent bonds. While these bonds are incredibly strong, they will never reconnect once broken. In order to make a rubber self-healable, the team needed to make the bonds connecting the polymers reversible, so that the bonds could break and reform. "Previous research used reversible hydrogen bonds to connect polymers to form a rubber but reversible bonds are intrinsically weaker than covalent bonds," said Li-Heng Cai, a postdoctoral fellow at SEAS and corresponding author of the paper. "This raised the question, can we make something tough but can still self-heal?" Cai, along with co- workers developed a hybrid rubber with both covalent and reversible bonds. The concept of mixing both covalent and reversible bonds to make a tough, self-healing rubber was proposed in theory by Cai but never shown experimentally because covalent and reversible bonds don't like to mix. "These two types of bonds are intrinsically immiscible, like oil and water," said Cai. So, the researchers developed a molecular rope to tie these two types of bonds together. This rope, called randomly branched polymers, allows two previously unmixable bonds to be mixed homogeneously on a molecular scale. In doing so, they were able to create a transparent, tough, self-healing rubber. Typical rubber tends to crack at certain stress point when force is applied. When stretched, hybrid rubber develops so-called crazes throughout the material, a feature similar to cracks but connected by fibrous strands. These crazes redistribute the stress, so there is no localized point of stress that can cause catastrophic failure. When the stress is released, the material snaps back to its original form and the crazes heal. Harvard's Office of Technology Development has filed a patent application for the technology and is actively seeking commercialization opportunities. The self-healing ability is appealing for a wide variety of rubber products. "Imagine that we could use this material as one of the components to make a rubber tyre," said a researcher. "If you have a cut through the tyre, this tire wouldn't have to be replaced right away. Instead, it would self-heal while driving enough to give you leeway to avoid dramatic damage." "There is still a lot more to do," said researchers. "For materials science, it is not fully understood why this hybrid rubber exhibits crazes when stretched. For engineering, the applications of the hybrid rubber that take advantage of its exceptional combination of optical transparency, toughness, and self-healing ability remain to be explored. Moreover, the concept of using molecular design to mix covalent and reversible bonds to create a homogenous hybrid elastomer is quite general and should enable development of tough, self-healing polymers of practical usage."

Source https://www.sciencedaily.com/releases/2017/08/170816122342.htm

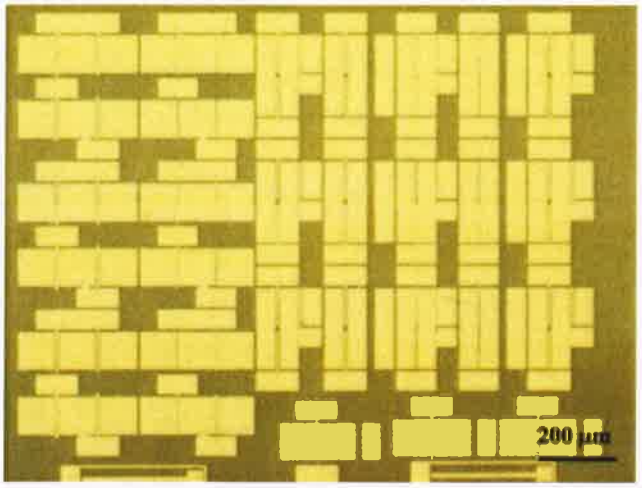
5. New Ultrathin Semiconductor Materials Exceed Some of Silicon's 'Secret' Powers

In this greatly enlarged cross-section of an experimental chip, the bands of black and white reveal alternating layers of hafnium diselenide – an ultrathin semiconductor material – and the hafnium dioxide insulator. The cross-section matches an overlaid color schematic on the right.

The next generation of feature-filled and energy-efficient electronics will require computer chips just a few atoms thick. For all its positive attributes, trusty silicon can't take us to these ultrathin extremes. Now, electrical engineers at Stanford have identified two semiconductors -- hafnium diselenide and zirconium diselenide -- that share or even exceed some of silicon's desirable traits, starting with the fact that all three materials can "rust." "It's a bit like rust, but a very desirable rust," said Eric Pop, an associate professor of electrical engineering. The new materials can also be shrunk to functional circuits just three atoms thick and they require less energy than silicon circuits. Although still experimental, the researchers said the materials could be a step toward the kinds of thinner, more energy-efficient chips demanded by devices of the future. Silicon has several qualities that have led it to become the bedrock of electronics, Pop explained. One is that it is blessed with a very good "native" insulator, silicon dioxide or, in plain English, silicon rust. Exposing silicon to oxygen during manufacturing gives chip-makers an easy way to isolate their circuitry. Other semiconductors do not "rust" into good insulators when exposed to oxygen, so they must be layered with additional insulators, a step that introduces engineering challenges. Both of the diselenides the Stanford group tested formed this elusive, yet high-quality insulating rust layer when exposed to oxygen. Not only do both ultrathin semiconductors rust, they do so in a way that is even more desirable than silicon. They form what are called "high-K" insulators, which enable lower power operation than is possible with silicon and its silicon oxide insulator. As the Stanford researchers started shrinking the diselenides to atomic thinness, they realized that these ultrathin semiconductors share another of silicon's secret advantages: the energy needed to switch transistors on -- a critical step in computing, called the band gap -- is in a just-right range. Too low and the circuits leak and become unreliable. Too high and the chip takes too much energy to operate and becomes inefficient. Both materials were in the same optimal range as silicon. All this and the diselenides can also be fashioned into circuits just three atoms thick, or about two-thirds of a nanometer, something silicon cannot do. "Engineers have been unable to make silicon transistors thinner than about five nanometers, before the material properties begin to change in undesirable ways," Pop said. The combination of thinner circuits and desirable high-K insulation means that these ultrathin semiconductors could be made into transistors 10 times smaller than anything possible with silicon today. "Silicon won't go away. But for consumers this could mean much longer battery life and much more complex functionality if these semiconductors can be integrated with silicon," Pop said. There is much work ahead. First, reseaechers must refine the electrical contacts between transistors on their ultrathin diselenide circuits. "These connections have always proved a challenge for any new semiconductor, and the difficulty becomes greater as we shrink circuits to the atomic scale," a researcher said. They are also working to better control the oxidized insulators to ensure they remain as thin and stable as possible. Last, but not least, only when these things are in order will they begin to integrate with other materials and then to scale up to working wafers, complex circuits and, eventually, complete systems. "There's more research to do, but a new path to thinner, smaller circuits -- and more energy-efficient electronics -- is within reach," Pop said.

Source https://www.sciencedaily.com/releases/2017/08/170811141107.htm

6. Logic Circuits with Diamond-Based Transistors

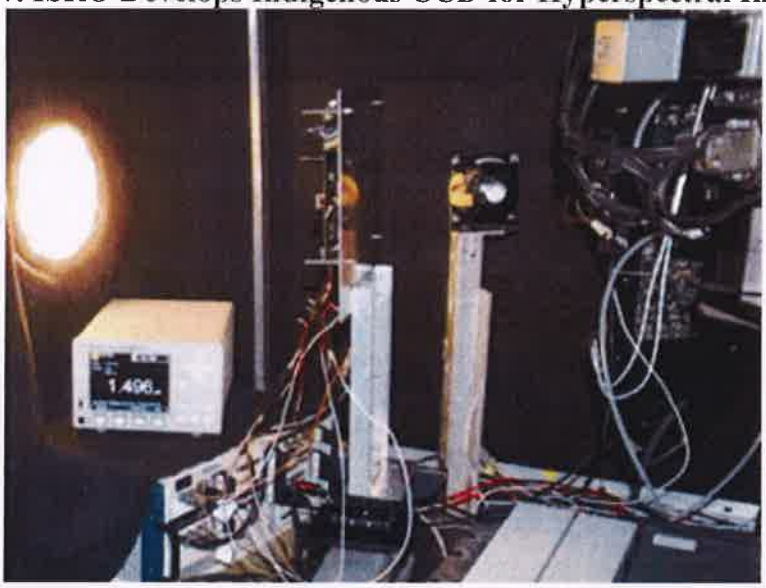


Micrograph of a fabricated logic circuit equipped with diamond-based transistors.

A NIMS research group led by Jiangwei Liu (independent scientist, Research Center for Functional Materials) and Yasuo Koide (coordinating director in the Research Network and Facility Services Division) has succeeded for the first time in the world in developing logic circuits equipped with diamond-based MOSFETs (metal-oxide-semiconductor field-effect-transistors) at two different operation modes. This achievement is a first step toward the development of diamond integrated circuits operational under extreme environments. Diamond has high carrier mobility, a high breakdown electric field and high thermal conductivity. Therefore, it is a promising material to be used in the development of current switches and integrated circuits that are required to operate stably at high-temperature, high-frequency, and high-power. However, it had been difficult to enable diamond-based MOSFETs to control the polarity of the threshold voltage, and to fabricate MOSFETs of two different modes—a depletion mode (D mode) and an enhancement mode (E mode)—on the same substrate. The research group has successfully developed a logic circuit equipped with both D- and E-mode diamond MOSFETs after making a breakthrough by fabricating them on the same substrate using a threshold control technique developed by the group. The research group identified the electronic structure in the interface between various oxides and hydrogenated diamond using photoelectron spectroscopy in 2012. The research group then succeeded in developing a diamond MOS (metal-oxide-semiconductor) capacitor with very low leakage current density and an E-mode hydrogenated diamond-based MOSFET in 2013 after going through many difficulties. The group then prototyped logic circuits by combining diamond-based MOSFETs with load resistors in 2014. Finally, the group developed techniques to control D- and E-mode characteristics of diamond-based MOSFETs and identified the control mechanism in 2015. These previous efforts led to the success made in this research project. The logic circuits with diamond-based transistors are promising devices to be used in the development of digital integrated circuits that are required to stably operate under extreme environments such as high-temperature as well as exposure to radiation and cosmic rays. This research was conducted in conjunction with the following projects: Leading Initiative for Excellent Young Researchers, under the sponsorship of the MEXT Human Resource Development Program for Science and Technology; "Development of new functional diamond electronic devices using a large amount of polarized charges", under the category of Grant-in-Aid for Scientific Research (A) sponsored by the MEXT Grants-in-Aid for Scientific Research; and "Fabrication of high-current output fin-type diamond field-effect transistors", under the category of Grant-in-Aid for Young Scientists (B) sponsored by the MEXT Grants-in-Aid for Scientific Research. Device fabrication was supported by the NIMS Nanofabrication Platform, established under the MEXT Nanotechnology Platform Japan program.

Source https://www.sciencedaily.com/releases/2017/08/170802083148.htm

7. ISRO Develops Indigenous CCD for Hyperspectral Imaging in Earth Observation Satellites

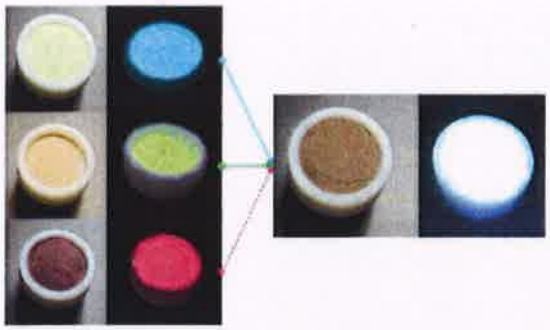


The testbench.

ISRO has developed an optical imaging detector array for hyperspectal imaging capabilities from Earth orbit. Hyperspectral imaging captures pixel level information across the electromagnetic spectrum, beyond the wavelengths that the human eye can recognise. The development came about during the search for a suitable imaging payload for the Hyperspectral Imaging Satellite (HySIS). The Vir-NIS payload is meant to capture hyperspectral images in the visible and near infrared regions of the electromagnetic spectrum. There are two related methods for obtaining hyperspectral images, push broom scanners and its variant, the whisk broom scanner. ISRO will be using the push broom scanning approach for this particular imaging instrument. The sensor is required to work from an orbit with an altitude of 630 km. Initially ISRO wanted to use an off the shelf detector array from an international commercial supplier, but the shortlisted detectors did not meet the various requirements of ISRO. So, the Space Applications Centre (SAC) and Semi Conductor Limited (SCL), an independent body under the Department of Space worked together for the indigenous development of a **Frame Transfer Charge Coupled Device**. The SAC came up with the device design, chip layout, chip architecture and the package design. A testbench was also developed to check if the software, hardware and firmware were working as required. The resulting optical imaging detector array was successfully tested to meet the requirements of ISRO.

Source http://www.firstpost.com/tech/news-analysis/isro-develops-indigenous-ccd-for-hyperspectral-imaging-in-earth-observation-satellites-3909775.html

8. Materials Governed by Light



Channelled aluminophosphate with various encapsulated dyes emitting in the blue (acridine), green (pyronin Y) and red (LDS 722) regions of the spectrum, occluded separately (left) or simultaneously in the correct proportions to produce white light (right), under ultraviolet excitation light.

Hybrid materials are those that combine components of differing origins (organic and inorganic) in order to obtain materials different from conventional ones and which display new or improved properties owing to the synergistic effect between their components. Rebeca Sola, a researcher in the Department of Physical Chemistry in the UPV/EHU's Faculty of Science and Technology, has developed and exhaustively characterised hybrid, photoactive materials -- which respond differently when exposed to excitation light -- which could have applications in highly different fields, such as optics and biomedicine. In the research conducted in this department, hybrid materials were obtained, among other things, by incorporating fluorescent dyes, which are routinely used in solution, into channelled inorganic structures. These materials firstly give the dye protection, thus rendering it more stable against degradation and increasing the useful service life of the devices that incorporate them, and secondly, they provide the system with rigidity, which is interesting as this has the potential to increase the photophysical properties of the organic hosts (the dyes). As the researcher explained, "highly fluorescent materials in which the dyes are found to be ordered were obtained, thus providing a highly anisotropic response to the linearly polarized light." In other words, materials that respond differently depending on the direction of the polarization of the incident light. Furthermore, it "is fairly straightforward," to synthesise these materials said Sola. "Crystalline structures in which the dye has already been occluded inside are obtained without any need to apply a diffusion process to insert the dye into the crystal." The researcher has thus obtained materials with a very wide range of optical properties. "Of great interest are those in which there is an artificial antenna effect with the ordering of the different kinds of dye and a unidirectional energy transfer," she said. This is translated into particles with multi-coloured fluorescence, which are capable of picking up the energy from light at one end and transferring it to the opposite end, which could be of interest with respect to integrating them into solar cells. Another of the materials obtained is a solid material that emits delayed fluorescence: instead of the fluorescence of the system turning off as soon as the excitation source is removed, as is usually the case, it persists for tenths of a second and is perfectly visible to the naked eye. "This kind of technology could be of interest in LED technologies," she explained. And materials capable of transforming incident laser light into light with double the amount of energy were also obtained. These materials not only allow the incorporation of a single dye into the inorganic structure, various dyes can also be simultaneously encapsulated. "With two dyes whose response is complementary, we have obtained fluorescent particles that change colour depending on the light polarization, and change from a blue fluorescent emission to a green one," added Sola. What is more, it is a reversible, reproducible process." By incorporating a third, red-emission dye in the correct proportion, a white-light emitting system was also obtained, "once again of interest for illumination systems," she concluded. White-light emitters were also obtained by adding small organic molecules to certain frameworks of metal ions and organic compounds known as MOFs (Metal Organic Frameworks); ambient-temperature phosphorescence was also obtained with them. "Phosphorescence is an emission process that routinely calls for very low temperatures to prevent the phosphorescent light from deactivating," explained Sola. The researchers have shown that hybrid materials may have applications in other fields, such as biomedicine. To do this, they used photosensitising substances suitable for photodynamic therapy. These are materials that combine organic and inorganic fragments to produce a kind of oxygen capable of causing the death of certain cells following excitation by light. Photodynamic therapy is a procedure used in dermatology, for example, to treat a range of skin diseases and even for different types of cancer. Materials that not only generate this type of cytotoxic oxygen but which are also fluorescent have been obtained. And "that makes them very useful for bioimaging as well," added the researcher. "

Source https://www.sciencedaily.com/releases/2017/08/170804092032.htm

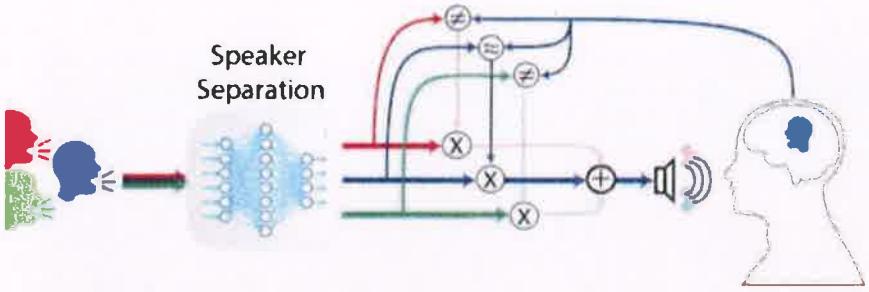
9. Solar Glasses Generate Solar Power

These Solar Glasses with lens-fitted semitransparent organic solar cells supply two sensors and electronics in the temples with electric power.

Organic solar cells are flexible, transparent, and light-weight -- and can be manufactured in arbitrary shapes or colours. Thus, they are suitable for a variety of applications that cannot be realized with conventional silicon solar cells. Researchers from KIT now present sunglasses with coloured, semitransparent solar cells applied onto lenses that supply a microprocessor and two displays with electric power. This paves the way for other future applications such as the integration of organic solar cells into windows or overhead glazing. "We bring solar power to places where other solar technologies fail," says Dr. Alexander Colsmann, Head of Organic Photovoltaics Group at KIT's Light Technology Institute (LTI). The "smart" Solar Glasses designed as a case study by the scientist and his team at KIT, is self-powered to measure and display the solar illumination intensity and ambient temperature. The solar cell lenses, perfectly fitted to a commercial frame, have a thickness of approx. 1.6 millimeters and weigh about six grams -- just like the lenses of traditional sunglasses. The microprocessor and the two small displays are integrated into the temples of the Solar Glasses. They show the illumination intensity and the ambient temperature as bar graphs. The Solar Glasses also work in indoor environments under illumination down to 500 Lux, which is the usual illumination of an office or a living area. Under these conditions, each of the "smart" lenses still generates 200 milliwatt of electric power -- enough to operate devices such as a hearing aid or a step counter. "The Solar Glasses we developed are an example of how organic solar cells may be employed in applications that would not be feasible with conventional photovoltaics," stresses a researcher who largely contributed to the development of the solar glasses at the Material Research Center for Energy Systems of KIT. In the eyes of the engineer, these solar cells, which are based on hydrocarbons, are very exciting devices due to their mechanical flexibility and the opportunity to adapt their colour, transparency, shape, and size to the desired application. According to the researcher, another field of application is the integration of solar cells into buildings: Since the glass facades of high-rise buildings must often be shaded, it is an obvious option to use organic solar modules for transforming the absorbed light into electric power. A future vision for the engineer, who works on the basic understanding of organic solar cell and semiconductor components at the Material Research Center for Energy Systems, is to coat large surfaces with organic solar cells using reel-to-reel technology. Their research was funded by the BMBF (Federal Ministry of Education and Research) within the scope of the POPUP project which is aimed at developing novel materials and device structures suitable for competitive mass production processes and applications in the field of organic photovoltaics.

Source https://www.sciencedaily.com/releases/2017/08/170802102800.htm

10. Cognitive Hearing Aid Filters Out the Noise



A cognitively controlled assistive hearing device can automatically amplify one speaker among many. To do so, a deep neural network automatically separates each of the speakers from the mixture, and compares each speaker with the neural data from the user's brain. The speaker that best matches the neural data is then amplified to assist the user.

People who are hearing impaired have a difficult time following a conversation in a multi-speaker environment such as a noisy restaurant or a party. While current hearing aids can suppress background noise, they cannot help a user listen to a single conversation among many without knowing which speaker the user is attending to. A cognitive hearing aid that constantly monitors the brain activity of the subject to determine whether the subject is conversing with a specific speaker in the environment would be a dream come true. Using deep neural network models, researchers at Columbia Engineering have made a breakthrough in auditory attention decoding (AAD) methods and are coming closer to making cognitively controlled hearing aids a reality. The study, led by Nima Mesgarani, associate professor of electrical engineering was done in collaboration with Columbia University Medical Center's Department of Neurosurgery and Hofstra-Northwell School of Medicine, and Feinstein Institute for Medical Research. Mesgarani's team developed an end-to-end system that receives a single audio channel containing a mixture of speakers by a listener along with the listener's neural signals, automatically separates the individual speakers in the mixture, determines which speaker is being listened to, and then amplifies the attended speaker's voice to assist the listener -- all in under 10 seconds. "This work combines the state-of-the-art from two disciplines: speech engineering and auditory attention decoding," says Mesgarani, who is also a member of the Data Science Institute and the Mortimer B. Zuckerman Mind Brain Behaviour Institute. "We were able to develop this system once we made the breakthrough in using deep neural network models to separate speech." His team came up with the idea of a cognitively controlled hearing aid after they demonstrated it was possible to decode the attended target of a listener using neural responses in the listener's brain using invasive neural recordings in humans. Two years later, they showed they could decode attention with non-invasive methods as well. "Translating these findings to real-world applications poses many challenges," notes a research scientist working with Mesgarani and lead author of the study. In a typical implementation of auditory attention decoding, researchers compare the neural responses recorded from a subject's brain with the clean speech uttered by different speakers; the speaker who produces the maximum similarity with the neural data is determined to be the target and is subsequently amplified. However, in the real world, researchers have access only to the mixture, not the individual speakers. "Our study takes a significant step towards automatically separating an attended speaker from the mixture," a researcher continues. "To do so, we built deep neural network models that can automatically separate specific speakers from a mixture. We then compare each of these separated speakers with the neural signals to determine which voice the subject is listening to, and then amplify that specific voice for the listener." The team tested the efficacy of their system using invasive electrocorticography recordings from neurological subjects undergoing epilepsy surgery. They identified the regions of the auditory cortex that contribute to AAD and found that the system decoded the attention of the listener and amplified the voice he or she wanted to listen to, using only the mixed audio. "Our system demonstrates a significant improvement in both subjective and objective speech quality measures -- almost all of our subjects said they wanted to continue to use it," Mesgarani says. "Our novel framework for AAD bridges the gap between the most recent advancements in speech processing technologies and speech prosthesis research and moves us closer to the development of realistic hearing aid devices that can automatically and dynamically track a user's direction of attention and amplify an attended speaker."

Source https://www.sciencedaily.com/releases/2017/08/170803204942.htm

Engineering innovation in India

An App to Track Missing People on High Seas

A mobile app, SARAT (Search And Rescue Aid Tool), that can help save lives and find lost objects at sea was released recently. The versatile tool has been developed by Indian National Centre for Ocean Information Services (Incois), Hyderabad, which is an autonomous agency under the Ministry of Earth Sciences. The SARAT app can assist in the search for over 64 types of missing 'objects', including boats, ships and people. While the web version was released last year, the mobile app will be available for download from the Google Play Store. "Conducting search and rescue operations at sea is extremely challenging and can be compared to the proverbial search for a needle in a haystack. Typically, search and rescue operations are most frequent during bad weather over the high seas, when fisherfolk inadvertently venture out and their vessels capsize," Incois said. The system mainly enables the Indian Coast Guard, Navy and Coastal Security Police to minimise search time during various operations to reduce loss of life, injury and property damage. In such exigencies, quick action is vital and hence this mobile app has been developed to make this system conveniently available to all, Incois said. The accuracy of SARAT is validated using a network of drifting buoys and other instruments. The system proved its mettle earlier by successfully assisting in the recovery of the Indian Coast Guard's missing Dornier aircraft off Chennai coast in 2015.

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