INDIAN NATIONAL ACADEMY OF ENGINEERING

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From the Editor's Desk

Engineering Talent

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Purnendu Ghosh
Chief Editor of Publications

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Nothing is more important than talent. Talent is an essential component for the prosperity and growth of a country. A talented can combine depth with breadth. About engineering talent, it is said, "The competition for engineering talent will become increasingly fierce, since without talent, success is unattainable." Talent is globally distributed. Subra Suresh, president of Carnegie Mellon University enlists four major trends in shaping the generation and use of engineering talent: (1) investments in research and education, (2) shifting demographics are transforming the hunt for talent, (3) grand challenges on a global scale, and (4) the policies that create talent are local or national, but the output of that talent has no borders.

A large proportion of engineers go into professions that are not based on science and technology. Engineering-based organisations need to create incentives for engineers so as not to lose potential employees to other sectors. This is not to suggest that engineers don't contribute to the economy when they are not working directly in engineering. Engineers are increasingly working on cross-functional and globally distributed teams. To meet the expectations of the employers, Universities are developing programs, such as undergraduate programs with an additional year of specialized study, keeping in view the start-up companies, creation of a minor in entrepreneurship, joint degree programs at the graduate level (combining, say, engineering with law or business). To attract and retain the really talented, among the means suggested include: give interesting and hard problems, give freedom and space to solve the problems, protect them from bureaucracy, and make provision for them to share the outcome, including profits.

ACADEMY ACTIVITIES

Engineers Conclave 2016

Engineers Conclave 2016 was held at Indian Institute of Technology (IIT) Madras during Sept 1-3, 2016. Prof. Bhaskar Ramamurthi, FNAE, Director, IIT Madras and Dr BN Suresh, President, INAE were the Co-Chairs of the Engineers Conclave 2016. The Chief Guest of Engineers Conclave 2016, Shri M Venkaiah Naidu, Hon'ble Minister for Urban Development, Housing & Urban Poverty Alleviation and Information & Broadcasting delivered his Address in the Inaugural Session on Sept 1, 2016 at IIT Madras, Chennai. During the Inaugural Session Prof Bhaskar Ramamurthi delivered the Welcome Address; Dr BN Suresh gave an overview of the aim of the conference; whereas the Keynote Address was delivered by Shri Vinay Sheel Oberoi, Secretary, Department of Higher Education, Ministry of HRD, GoI. Prof. C. Balaji, Convener EC 2016 proposed the Vote of Thanks. The first issue of the Research Journal "INAE Letters" was also released by Hon'ble Minister, Shri M Venkaiah Naidu during the Inaugural Session.

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Chief Guest, Shri M Venkaiah Naidu, Hon'ble Minister for Urban Development, Housing & Urban Poverty Alleviation and Information & Broadcasting delivering his address in the Inaugural Session

*(**L. to R.** Dr BN Suresh, President, INAE, Shri Vinay Sheel Oberoi, Secretary, HRD; Hon'ble Minister, Shri M Venkaiah Naidu and Prof Bhaskar Ramamurthi, Director, IIT Madras in the Inaugural Session)*

The themes of the Conclave were "Engineering Education 2020" coordinated by IIT Madras and "Smart Cities" coordinated by INAE. Prof. MS Ananth, FNAE was the Coordinator from IIT Madras for Theme I on "Engineering Education 2020" and Prof Prem Krishna, FNAE was the Coordinator of Theme –II on "Smart Cities". Eminent experts from Academia, R&D and Industry besides about 70 Fellows of INAE and Executives of the Ministry of Urban Development participated in Engineers Conclave 2016.

Three Plenary Talks by Prof Jagan Shah, Director, National Institute of Urban Affairs, New Delhi; Prof Anurag Kumar, Director, Indian Institute of Science, Bangalore and Prof YV Reddy Former Governor, Reserve Bank of India were organized during the Conclave. The two and a half day Technical programme featured invited talks by eminent experts from Academia, R&D, Government and Industry. The Inaugural Session was followed by two parallel technical sessions on respective themes. Each theme had four technical sessions. The Technical Sessions under Theme I on "Engineering Education 2020" were on: (i) Curriculum and Pedagogy, (ii) Research Excellence and Innovation, (iii) International Benchmarks and MOOCs and (iv) Industry Expectations and Skill Development. Similarly, the Technical Sessions under Theme II on "Smart Cities" were on: (i) Transportation and Architecture, (ii) Urban Water Management, (iii) e-Governance/ICT Enabling and (iv) Energy and Ecology.

A Panel Discussion was held in the morning of Sept 3, 2016 on each of the themes. Prof MS Ananth chaired the Panel Discussion on the theme of "Engineering Education 2020" and Prof Prem Krishna chaired the Panel Discussion on "Smart Cities". A Valedictory Session was held after the Panel Discussion during which Dr BN Suresh, President, INAE presented the Introductory Remarks while Prof MS Ananth and Prof Prem Krishna presented a summary of the deliberations under the two themes of "Engineering Education 2020" and "Smart Cities" respectively. Prof Bhaskar Ramamurthi, Director IIT Madras delivered the Valedictory Address during the Valedictory Session. During the Valedictory Session the recommendations emanating from the two days deliberations were summarized. The two important themes of the Conclave focused on cutting edge solutions and specific recommendations for further follow up action are under finalization.

CAETS 2016 Annual Meeting and Engineering a Better World Conference

CAETS 2016 Annual Meeting and Engineering a Better World Conference was hosted by Royal Academy of Engineering, UK on Sept 12-16, 2016 at London. INAE delegation led by Dr BN Suresh, President, INAE participated in the event. The CAETS Energy Committee meeting was held on Sept 12, 2016 which was Chaired by Dr Baldev Raj, Immediate Past President, INAE; Past President, CAETS and Chairman CAETS Energy Committee. The CAETS Energy Committee Report on "Transitioning To Lower Carbon Economy Technology and Engineering Considerations in Building and Transportation Sectors" compiled by INAE was released during the meeting.

The Engineering a Better World Conference was held on Sept 13-14, 2016 during which eminent engineering personalities and senior dignitaries from across the world delivered invited lectures. Dr BN Suresh, President, INAE delivered a talk on "The Academy as a Fellowship" during the conference. During the CAETS meetings, the Council Meeting on Sep 15, 2016 a Council Discussion Topic on "Diversity" was held during which Dr Kamachi Mudali, FNAE made a brief presentation on behalf of INAE.

INAE Annual Convention

This year, the INAE Annual Convention is being held at Space Applications Centre (SAC), Ahmedabad on Dec 8-10, 2016 which will be preceded by Governing Council meeting on 7th Dec 2016. Mr. Tapan Misra, Director, SAC has kindly consented to host the event. INAE Fellows and Young Associates have been invited to participate in the Annual Convention. The Block Programme of the INAE Annual Convention can be viewed at the link .....

Research Journal -INAE Letters

*(**L. to R.** Dr BN Suresh, President, INAE, Shri Vinay Sheel Oberoi, Secretary, HRD; Hon'ble Minister, Shri M Venkaiah Naidu and Prof Bhaskar Ramamurthi, Director, IIT Madras during the release of INAE Letters)*

INAE has recently launched a quarterly journal "INAE Letters" published by M/s Springer. The objective of the journal is to provide a medium for rapid publication of new research results and invited short review articles across different domains of engineering science and technology. The first issue of the Research Journal "INAE Letters" was released by the Shri M Venkaiah Naidu, Hon'ble Minister for Urban Development, Housing & Urban Poverty Alleviation and Information & Broadcasting on Sep 1, 2016 at IIT Madras, Chennai during the sidelines of the Engineers Conclave 2016. Dr Purnendu Ghosh, Chief Editor of Publications, INAE and Executive Director, Birla Institute for Scientific Research, Jaipur is the Editor-in-Chief of INAE Letters. The website for the Research Journal "INAE Letters" to include facility for submission of papers online has also been launched. The soft copy of the INAE Letters can be viewed at the link http://www.springer.com/engineering/journal/41403

Creation of Data for INAE Expert Pool

INAE Expert Pool was created with the aim of identifying domain experts in various disciplines of engineering. There has been a good response from the Fellows and Young Associates in uploading their particulars on the INAE Expert Pool website. The INAE Fellows and Young Associates who have not uploaded their particulars are requested to submit their profile details online at the link http://inae.in/expert-search/index.php/inae-members-form The details of the INAE expert Pool have since been shared with DST, TIFAC, Niti Aayog and Office of PSA. The creation of the website on Expert Pool has been appreciated by all the agencies and the data would be used by them in identifying suitable domain experts and to involve the experts in their activities.

Opening of Facebook and Twitter Accounts by INAE

The Department of Science and Technology (DST) has recommended enhancing Social Media Optimization through creation of Facebook and Twitter accounts. Accordingly a Facebook page and Twitter Handle for INAE have been created. All INAE Fellows are requested to visit the page and post their comments, if any. The Facebook page of INAE can be viewed at https://www.facebook.com/pages/Indian-National-Academy-of-Engineering/714509531987607?ref=hl and Twitter handle at https://twitter.com/inaehq1

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 recent visits of industry experts under this scheme are given below.

Dr Chaitanyamoy Ganguly Retired Distinguished Scientist, DAE	Jadavpur University, Kolkata August 8-9, 2016	Delivered Lectures on "Introduction to Fission Nuclear Energy-Power & Non-power Applications" and "Nuclear Power Program in India". As per the feedback from the Engineering College, the lectures were relevant as the topics covered are part of Reactor Physics and Engineering I course.
Dr Manish Roy Scientist 'F', Defence Metallurgical Research Laboratory, Hyderabad	Indian Institute of Engineering Science and Technology, Shibpur August 16-17, 2016	Delivered lectures on "Erosion Oxidation Interaction of Metallic Materials" and " Surface engineering for Enhanced Tribological Performance of Aero Engine". He also guided projects on "Hydrogen Embrittlement of 440 C bearing steel for M.Tech thesis and identified projects on "Transmission Electron Microscopy of Bainitic Steel". The Faculty Coordinator in his feedback to INAE remarked that these interactions help new and pragmatic ideas get translated into practice and encourages new collaborations with right mix of expertise.
Mr. Yogeshchandra S Trivedi Executive Vice President & Member of Board , L&T Heavy Engineering	Faculty of Technology & Engineering, M.S. University, Baroda August 20, 2016	Delivered lecture on "Interactive Session on Welding, Metallurgy and NDT". As per the feedback from the engineering institution, the scheme is very helpful for students to understand practical applications of the subject. Ten projects have been identified for current academic year based on live training in Industry. The curriculum of ME-Welding Technology course was also designed under the guidance of the industry expert.
Mr S Madivaanan Formerly Additional Director, CVRDE, Chennai	Velammal Engineering College, Chennai August 26, 2016	Delivered Lecture on "Future Weapons Part I". Guided project of title "Unnamed Vehicle". According to the feedback from the engineering college, the Industry expert shall participate in curriculum revision. The Faculty Coordinator in his feedback to INAE, mentioned that the scheme

		provides an opportunity to gain rich experience for both faculty members and students. The scheme helps the budding engineers to understand industrial applications and requirements and also helps to carry out good innovative projects.

International Conferences/Seminars being organized by IITs/other Institutions

To view a list of International Conferences/Seminars being held in the month of October 2016 click here.

Honours and Awards

1.	Dr. BN Suresh, FNAE, President, INAE , Vikram Sarabhai Distinguished Professor, ISRO Headquarters, Bangalore was conferred the "Sir M Visweswariah Science Award" on Sept. 17, 2016 for his outstanding contributions to Space science research and Education in the 12th Karnataka Science Congress held at Bidar, Karnataka, by the Karnataka Branch of "Vijnana Bharathi", (Science India)
2.	Dr. Bhakta B. Rath, FNAE, FASM, Associate Director of Research; Head Materials Science & Technology Directorate; Naval Research Laboratory, Washington, DC is being conferred the Medal for the Advancement of Research by ASM International "For leadership in promoting basic research and advanced exploratory developments in multi-disciplinary fields of materials science and engineering and promoting technological innovation for commercial sector and for national security." The Award will be presented at ASM's Annual Awards Dinner on Oct 25, 2016 in Salt Lake City, UT, during Materials Science & Technology 2016 (MS&T '16).
3.	Prof KA Natarajan, FNAE, Department of Materials Engineering, Indian Institute of Science Bangalore was conferred the NIGIS Lifetime Achievement Award by the NACE International Gateway India Section during CORCON 2016 Corrosion Conference and Expo held during Sept 18-21, 2016 at New Delhi.
4.	Prof A.K. Tripathy, FNAE, Senior Professor, Silicon Institute of Technology, Bhubaneswar has been awarded the 2016 prestigious Visvesvaraya award of Odisha Engineer' forum which was conferred on 15th Sept, 2016 - Engineer's day.
5.	Dr Venkata Narayana Padmanabhan, FNAE, Principal Researcher and Research Manager, Microsoft Research India, Bangalore and Prof Avinash Kumar Agarwal, FNAE, Poonam and Prabhu Goyal Endowed Chair, Department of Mechanical Engineering, Indian Institute of Technology (IIT) Kanpur have been selected for conferment of the Shanti Swarup Bhatnagar Award for science and technology for the year 2016.

News of Fellows

1.	Shri Anil Anand, FNAE, Director Technical, Microtrol Sterilisation Services Pvt Ltd, Mumbai and Formerly Director (Reactor Projects Group), BARC, Mumbai has authored a book titled "Submarine Propulsion Muscle Power to Nuclear" which was released on Sept 18, 2016 at Mumbai.
2	Prof. D N Singh, FNAE, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai has recently been invited to become Fellow of the Institution of Civil Engineers (ICE), London, by a Presidential Invitation.

PROGRAMME

ANNUAL CONVENTION – DECEMBER 8-9, 2016

DECEMBER 8

0930 – 1000 hrs. - **Registration**

1000 – 1100 hrs. - **Inaugural Session**

- Welcome by Mr. Tapan Misra, Director, Space Applications Centre.
- Presidential Address by Dr. BN Suresh, President, INAE .
- Address by Chief Guest from Industry
- Address by Guest of Honour, Shri AS Kiran Kumar, Chairman, Space Commission, Chairman, ISRO and Secretary, Department of Space.
- Vote of Thanks.

1100 – 1130 hrs. - **TEA**

1130-1230 hrs. - **Award lectures by Dr. PS Goel and Dr. VK Aatre, Awardees for Life Time Contribution Award in Engineering 2016.**

1230 – 1330 hrs. - **Technical Presentations by Fellows & Young Engineers (parallel session)**

Parallel Session-1	**Parallel Session-2**
Engineering Section I (Civil Engineering), Engineering Section III (Mechanical Engineering), Engineering Section IV (Chemical Engineering), Engineering Section VII (Aerospace Engineering) and Engineering Section VIII (Mining, Metallurgical and Materials Engineering)	Engineering Section II (Computer Engineering and Information Technology), Engineering Section V (Electrical Engineering), Engineering Section VI (Electronics & Communication Engineering), Engineering Section IX (Energy Engineering) and Engineering Section X (Interdisciplinary Engineering and Special Fields)

1330– 1430 hrs. - **LUNCH**

1430 – 1630 hrs. - **Technical Presentations by Fellows & Young Engineers continued**

Parallel Session-1	**Parallel Session-2**
Engineering Section I (Civil Engineering), Engineering Section III (Mechanical Engineering), Engineering Section IV (Chemical Engineering), Engineering Section VII (Aerospace Engineering) and Engineering Section VIII (Mining, Metallurgical and Materials Engineering)	Engineering Section II (Computer Engineering and Information Technology), Engineering Section V (Electrical Engineering), Engineering Section VI (Electronics & Communication Engineering), Engineering Section IX (Energy Engineering) and Engineering Section X (Interdisciplinary Engineering and Special Fields)

1630 – 1700 hrs. - **HIGH TEA WITH AWARD WINNERS**

1700-1830 hrs. - **Award Function**

- ***Opening Remarks by Dr. BN Suresh, President, INAE.***
- ***Presentation of Awards to Innovative Student Projects Awardees 2016 and INAE Young Engineer Awardees 2016***
- ***Presentation of Awards to Prof. SK Sarangi and Dr. SN Singh Outstanding Teachers Awardees 2016***
- ***Presentation of Awards to Dr. V Adimurthy, Prof. Jai Krishna Memorial Awardee 2016***
- ***Presentation of Awards to Prof. VS Borkar, Prof. SN Mitra Memorial Awardee 2016***
- ***Presentation of Awards to Dr. PS Goel and Dr. VK Aatre, Life Time Contribution Awardees 2016***
- ***Vote of Thanks***

1830 – 1845 hrs **BREAK**

1845 – 2000 hrs - **Cultural Programme**

2000 – 2130 hrs - **INAE Fellows Annual Dinner**

DECEMBER 9

0900 – 1100 hrs. - **28th Annual General Meeting of Fellows 2016**

- ***Opening Remarks by Dr. BN Suresh, President, INAE***
- ***Induction Ceremony of newly elected Fellows***
- ***Agenda***
- ***Brainstorming Session***
- ***Presentations by Conveners of Sectional Committees highlighting the activities planned for the next one year* (5 minutes each)**

1100 – 1130 hrs. - **TEA**

1130 –1300 hrs. **Plenary Talks**

- Plenary Talk by an eminent Engineer showcasing the success story of Engineering in India **(45 minutes)**
- Plenary Talk by an eminent personality on a topic of general interest **(45 minutes)**

1300– 1330 hrs. - **LUNCH**

1330 – 1430 hrs. **Industry Session**

- **Three Lectures by Young Start up Entrepreneur (20 mins each)**

1430-1700 hrs - **Technical Presentations by Fellows & Young Engineers continued**

Parallel Session-1

Engineering Section I (Civil Engineering), Engineering Section III (Mechanical Engineering), Engineering Section IV (Chemical Engineering), Engineering Section VII (Aerospace Engineering) and Engineering Section VIII (Mining, Metallurgical and Materials Engineering)

Parallel Session-2

Engineering Section II (Computer Engineering and Information Technology), Engineering Section V (Electrical Engineering), Engineering Section VI (Electronics & Communication Engineering), Engineering Section IX (Energy Engineering) and Engineering Section X (Interdisciplinary Engineering and Special Fields)

1700– 1730 hrs. - **TEA**

International Conference on Recent Trends in "Mechanical, Material, Industrial, Automotive, Aeronautical and Nano-Technology" (MIANT-2016) on Oct 1, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=176009

International Conference on Innovative Research in "Civil Engineering, Architecture and Environmental Engineering for Global Sustainability" (CEAEGS- 2016) on Oct 1, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=176232

International Conference on Recent Trends in Engineering & Technology on Oct 3-5, 2016 at Kochi
http://www.conferencealerts.com/show-event?id=173176

International Conference on Computational Science and Engineering on Oct 4-6, 2016 at Kolkata
http://www.conferencealerts.com/show-event?id=168848

International Conference on Computational Systems and Information Technology for Sustainable Solutions on Oct 6-8, 2016 at Bangalore
http://www.conferencealerts.com/show-event?id=169705

International Conference on Nanoscience and Nanotechnology (ICNAN'16) on Oct 19-21, 2016 at Vellore
http://www.conferencealerts.com/show-event?id=174983

International Conference on Smart Engineering Materials-ICSEM-2016 on Oct 20-22, 2016 at Bangalore
http://www.conferencealerts.com/show-event?id=173110

IEEE International Conference on Communication and Electronics Systems (ICCES 2016) on Oct 21-22, 2016 at Coimbatore
http://www.conferencealerts.com/show-event?id=169710

International Conference on Innovative Research in "Mechanical, Electrical, Electronics, Civil, Computer Science and Information Technology" (MECIT-2016) on Oct 23, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=176230

When I Look Back My Career at BARC...

Manjit Singh

I joined BARC in the year 1972 after my graduation from Punjabi University, Patiala, Punjab. After one year orientation course at BARC Training School, I joined Reactor Control Division of BARC in the year 1973. I have been lucky to have worked under the guidance of a great man (late) Shri S. N. Seshadri during the period from 1973 till 1986, when he suddenly expired at the age of about 56 years. Shri Seshadri could motivate a large number of persons like me to take up challenges and deliver at any cost. I have also been lucky to have a team of very competent engineers reporting to me.

During early days, PHWRs were built with the provision of dumping the Heavy Water moderator for reactor shutdown. Subsequently, it was decided to introduce solid absorber elements into the reactor core using remotely operated reactivity control mechanisms. Indian research reactor 'DHRUVA' and power reactor at Narora were designed with mechanical shutdown system. Being safety critical system, design of shutdown mechanism is challenging in itself. At the time of reactor start-up, the absorber elements are withdrawn one-by-one and for shutdown, rod falls freely into the reactor core in a given time period, also ensuring minimum terminal velocity at the end of its travel. Moreover, depending upon reactor layout and number of such mechanisms to be provided on the top of the reactor, space available for the mechanism is limited, which makes it a custom-built design. Design of the mechanism is also dictated by the weight of the absorber element, its travel, withdrawal time and its rod drop characteristics. Shutdown mechanism is built with modular construction giving ease of maintenance, fail-safe and free fall for the required length of travel giving consistent rod drop performance. This assignment was first-of-its-kind for Indian research and power reactors. Being safety critical system of the reactor, design is qualified through prototyping and subjecting it to life-cycle testing to demonstrate its reliability and repeatability in its performance. Design of shutdown mechanism adopted in the research reactor DHRUVA and power reactor at Narora is considered to be 'Benchmark design' for subsequent reactors.

The next challenge on which my team worked was design and development of BARC Coolant Channel Inspection System (BARCIS) for in-service inspection (ISI) of coolant channel of 220MWe and 540MWe PHWRs. The assignment was given by Dr. Anil Kakodkar, our Ex-Chairman, AEC in 1991. The system was successfully developed in a record time of less than a

year. A number of BARCIS units are in regular use at various Nuclear Power Plant Sites. I feel proud that our team could contribute significantly towards Nuclear Power Programme of the Department. BARCIS has been in regular use at all our PHWRs for ISI activity and thus forming an important tool in the coolant channel health assessment programme of PHWRs.

Based on the successful deliveries mentioned above, Dr. Kakodkar entrusted the development of robust remote handling and robotic products for use in radioactive environment to my team in the year 2000. We could deliver rugged duty mechanical master-slave manipulator and servo-manipulator to various users. We also developed mobile robots for remote survey and inspection of radioactive areas. We took the challenge of building a mobile robot with on-board manipulator and remove Anti-Tank Mine Fuzes remotely at Ordnance Factory Khamaria, Jabalpur, in the year 2007. On another front, we developed an automated Guided Vehicle (AGV) based Materials Transfer System for use in the manufacturing environment in the year 2010.

The most satisfactory experience has been the design and development of indigenous low-cost Teletherapy Machine for the treatment of cancer. Cancer is a major public health concern in our country, and due to various reasons the incidence of cancer is expected to increase substantially in coming years. Considering the growing need of such machines in the country, we have developed a state-of-the-art machine Bhabhatron incorporating the latest concepts in safety, control and user interface in the year 2005.This low cost machine has a number of features superior to any other machine in the category.More than 30 machines are operating at various cancer hospitals and treating large number of patients on regular basis. These include rural and semi-urban areas where our machine has unique advantage of running even on battery/ small generator during power-cuts. We could also deliver a robust Radiotherapy Simulator to localize the treatment volume to be subjected to radiation during radiotherapy treatment, in the year 2011.Currently we are working for the development of an indigenous low-cost robotic system for minimally invasive surgery which is a special type of servo-manipulator. The imported systems are prohibitively expensive. Based on our experience in servo-manipulator technology, we are confident of meeting this challenge in reasonable time.

The experience of working at BARC has been satisfying and I will cherish this forever. I consider the motivation from our leaders and team-work have resulted in success in all our endeavors.

Some Conjectures and Random Thoughts

PA Lakshminarayanan

Acoustics: Arranging microphones in a studio and in a live concert

The sound experts in a recording studio would pick up the sound of instruments by placing the microphones close to the instruments, later moderate the strength and frequency of the composition of sound from each instrument differently and blend them for a pleasant experience of the listeners. In a concert, however, the sound engineer may just amplify the total sound as would be experienced by a listener at a reasonable distance. Hence, the microphones will be kept not near the instruments or the performer but at a distance, usually above the players' heads so that the sounds are picked up for the nearly true experience. However, in most of the Indian concerts sounds from all the instruments are given weights with either equal or distorted. The experience is not pleasant, especially if the amplified sound from percussion instruments overwhelms others.

History of Science and Economic Politics

The conventional thinking is that with the colonizing by the British some three centuries back, Indian economy saw a downtrend and it is still struggling to regain its premiere position. Politics and economics are closely related in any country and for a large country –emotionally or politically integrated as a unit- science and engineering importantly dictate the economics of the country. After repeated external invasions, the repressive rulers from 1000 CE who had no respect for the existing or new knowledge that was dawning elsewhere punished the quest for knowledge. This was the time when Galileo, Newton, Hughes and other great scientists were using new methods of enquiry and founded new knowledge. Under tremendous pressure, the Indian scientific community was already cracking and the fabric of the society was tearing into smithereens, leave alone any opportunity to learn the new developments in the world. It took very little effort for the British to have a cakewalk and the people already under strain invited them with open arms and the rest is history. Thus, the persecution of knowledge seekers over centuries demoralized them and they entered a shell and lost out in obtaining or creating new knowledge.

Galaxies, stars and planets

The observable universe exploded from nothing in a small time and then expanded slowly when the dark matter appeared to limit the rate of expansion. While expanding, it created knots connected by ribbons as it would happen if a ball of dough is pulled in all directions; the dough would tear into fibres with vast amount of empty space in between. These ribbons constitute of

galaxies which are essentially two dimensional discs with mostly even number of tails from their centres where black holes exist. The angular velocity of the outer most part of the tail rotating about the axis of the disc is less than that of the inner parts and the tails form the shape of a volute. The tails contain and stars and planetary systems or dust systems which are proto planets. The planetary or dust systems and the stars are mostly in a plane with very little change in the azimuth of the orbits. This is the result of conservation of angular momentum of the original star from which two (most probably even number of) dust streams burst out; the angular velocity of the revolving streams is slow at the extreme periphery relative to those inside. Also the density at the extreme was light as the lighter components of the dust storm would travel farther from the star against the star's gravitational force. At any radius, the two limbs would revolve at nearly equal angular velocity; the slight inequality would drive them to collision over a period of time and this could cause satellites for the condensing dusts or proto-planets and displace the planets to elliptical orbits.

Poisson, bias cut and draping a sari

Poisson's ratio is the proportional rate at which strain will be generated in the direction perpendicular to that in which the stress is applied. The result is to limit the change in volume of the material because of the applied stress. The induced strain is opposite in sign to the applied strain. In a homogeneous material, for example, a steel bar, the ratio is also homogeneous in all directions. However, when you consider of sheet of material too thin to model it as homogeneous or having fibres aligned in specific directions the ratio is dependent on the direction. Take for example, a conventional woven cloth, where there is a waft and a warp in perpendicular directions (x and y). At an angle of 45° to the x axis, the ratio drops. In such a case, the material behaves differently to stresses in different directions. This is exploited in bias cut of fabrics. Here, the stress is by the weight of the fabric itself. If the waft is along the direction of gravity, the fabric is relatively stiff in the direction perpendicular to the surface; when the waft is at 45° to the direction of the gravity the surface becomes highly flexible. This results in the fabric clinging to the body of the wearer. In India, uncut clothes like saris are worn at 45° at the back and on the front from time immemorial to bring out the features of the wearer, gracefully.

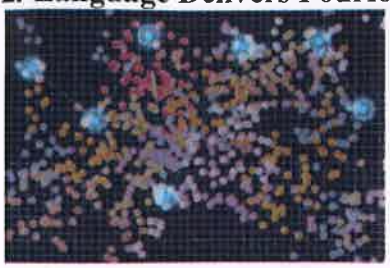
Civil Engineering

1. DONG Energy Installs World's Largest Wind Turbine

Danish wind energy giant DONG Energy has completed the installation of the world's largest wind turbines in September 2016 at the Burbo Bank Extension offshore wind farm in England. DONG Energy announced last month that it had successfully completed the installation of the first of thirty-two 8 MW wind turbines at the Burbo Bank Extension offshore wind farm which it is developing, currently under construction in Liverpool Bay, off the west coast of England. The 8 MW wind turbines, built by Vestas, are the largest in the world, standing at 195 meters. This is the first time Vestas' V164-8.0 MW wind turbines will be used in an offshore wind farm, though certainly not the last, as the number of extra-large-scale offshore wind farms continue to grow. Upon completion, the Burbo Bank Extension will have a final capacity of 258 MW, and generate enough electricity to supply approximately 230,000 UK homes with clean electricity. "The performance of the 8 MW turbine from Vestas is very promising," Samuel Leupold, Executive Vice President in DONG Energy, said at the time. "I see this as a very concrete step towards reducing the cost of electricity from offshore wind. A competitive market for all components is essential to accomplishing this. I look forward to working with Vestas and the other members of our supply chain to find further reductions in the cost of electricity." The Burbo Bank Extension is expected to reach completion and full commissioning in the first half of 2017.

Source https://cleantechnica.com/2016/09/12/dong-energy-installs-worlds-largest-wind-turbine/

2. Language Delivers Fourfold Speedups on Big-Data Problems



Researchers have designed a new programming language that lets application developers manage memory more efficiently in programs that deal with scattered data points in large data sets. In tests on several common algorithms, programs written in the new language were four times as fast as those written in existing languages.

In today's computer chips, memory management is based on what computer scientists call the principle of locality: If a program needs a chunk of data stored at some memory location, it probably needs the neighbouring chunks as well. But that assumption breaks down in the age of big data, now that computer programs more frequently act on just a few data items scattered arbitrarily across huge data sets. Since fetching data from their main memory banks is the major performance bottleneck in today's chips, having to fetch it more frequently can dramatically slow program execution. Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) recently presented a new programming language, called Milk, that lets application developers manage memory more efficiently in programs that deal with scattered data points in large data sets. In tests on several common algorithms, programs written in the new language were four times as fast as those written in existing languages. But the researchers believe that further work will yield even larger gains. The reason that today's big data sets pose problems for existing memory management techniques, explains Saman Amarasinghe, a professor of electrical engineering and computer science, is not so much that they are large as that they are what computer scientists call "sparse." That is, with big data, the scale of the solution does not necessarily increase proportionally with the scale of the problem. Amarasinghe says, an online bookseller with, say, 1,000 customers might like to provide its visitors with a list of its 20 most popular books. It doesn't follow, however, that an online bookseller with a million customers would want to provide its visitors with a list of its 20,000 most popular books. Today's computer chips are not optimized for sparse data -- in fact, the reverse is true. Because fetching data from the chip's main memory bank is slow, every core, or processor, in a modern chip has its own "cache," a relatively small, local, high-speed memory bank. Rather than fetching a single data item at a time from main memory, a core will fetch an entire block of data. And that block is selected according to the principle of locality. It's easy to see how the principle of locality works with, say, image processing. If the purpose of a program is to apply a visual filter to an image, and it works on one block of the image at a time, then when a core requests a block, it should receive all the adjacent blocks its cache can hold, so that it can grind away on block after block without fetching any more data. But that approach doesn't work if the algorithm is interested in only 20 books out of the 2 million in an online retailer's database. If it requests the data associated with one book, it's likely that the data associated with the 100 adjacent books will be irrelevant. Going to main memory for a single data item at a time is woefully inefficient. Milk simply adds a few commands to OpenMP, an extension of languages such as C and Fortran that makes it easier to write code for multicore processors. With Milk, a programmer inserts a couple additional lines of code around any instruction that iterates through a large data collection looking for a comparatively small number of items. Milk's compiler -- the program that converts high-level code into low-level instructions -- then figures out how to manage memory accordingly. With a Milk program, when a core discovers that it needs a piece of data, it doesn't request it -- and a cacheful of adjacent data -- from main memory. Instead, it adds the data item's address to a list of locally stored addresses. When the list is long enough, all the chip's cores pool their lists, group together those addresses that are near each other, and redistribute them to the cores. That way, each core requests only data items that it knows it needs and that can be retrieved efficiently. That's the high-level description, but the details get more complicated. In fact, most modern computer chips have several different levels of caches, each one larger but also slightly less efficient than the last. The Milk compiler has to keep track of not only a list of memory addresses but also the data stored at those addresses, and it regularly shuffles both around between cache levels. It also has to decide which addresses should be retained because they might be accessed again, and which to discard. Improving the algorithm that choreographs this intricate data ballet is where the researchers see hope for further performance gains.

Source https://www.sciencedaily.com/releases/2016/09/160913134149.htm

3. '4-D Printing' A New Dimension for Additive Manufacturing

LLNL researchers have successfully demonstrated the 3D printing of shape-shifting structures that can fold or unfold to reshape themselves when exposed to heat or electricity. Here, researchers examine a stent that can expand when exposed to heat.

A team of Lawrence Livermore National Laboratory researchers have demonstrated the 3D printing of shape-shifting structures that can fold or unfold to reshape themselves when exposed to heat or electricity. The micro-architected structures were fabricated from a conductive, environmentally responsive polymer ink developed at the Lab. Lab scientists and engineers revealed a strategy for creating boxes, spirals and spheres from shape memory polymers (SMPs), bio-based "smart" materials that exhibit shape-changes when resistively heated or when exposed to the appropriate temperature. While the approach of using responsive materials in 3D printing, often known as "4D printing," is not new, LLNL researchers are the first to combine the process of 3D printing and subsequent folding (via origami methods) with conductive smart materials to build complex structures. The researchers created primary shapes from an ink made from soybean oil, additional co-polymers and carbon nanofibers, and "programmed" them into a temporary shape at an engineered temperature, determined by chemical composition. Then the shape-morphing effect was induced by ambient heat or by heating the material with an electrical current, which reverts the part's temporary shape back to its original shape. Ultimately, researchers can use the materials to create extremely complex parts. "If we printed a part out of multiple versions of these formulations, with different transition temperatures, and run it through a heating ramp, they would expand in a segmented fashion and unpack into something much more complex," a researcher said. Through a direct-ink writing 3D printing process, the team produced several types of structures -- a bent conductive device that morphed to a straight device when exposed to an electric current or heat, a collapsed stent that expanded after being exposed to heat, and boxes that either opened or closed when heated. The technology, the researchers said, could have applications in the medical field, in aerospace (in solar arrays or antennae that can unfold), as well as flexible circuits and robotic devices."We have these materials with 3D structures but they have extra smart properties; they can retain a memory of the previous structure," said Lab staff scientist. "It opens up a whole new property set. If you can print with these polymer composites you can build things and electrically activate them to unfold. Instead of a dumb lump, you are left with this sentient, responsive material."

Source https://www.sciencedaily.com/releases/2016/08/160823141806.htm

4. Asphalt-Based Carbon-Capture Material Advances

Rice University scientists have improved their asphalt-derived porous carbon's ability to capture carbon dioxide, a greenhouse gas, from natural gas. The capture material derived from untreated Gilsonite asphalt has a surface area of 4,200 square meters per gram.

A Rice University laboratory has improved its method to turn plain asphalt into a porous material that can capture greenhouse gases from natural gas. Rice researchers showed that a new form of the material can sequester 154 percent of its weight in carbon dioxide at high pressures that are common at gas wellheads. Raw natural gas typically contains between 2 and 10 percent carbon dioxide and other impurities, which must be removed before the gas can be sold. The cleanup process is complicated and expensive and most often involves flowing the gas through fluids called amines that can soak up and remove about 15 percent of their own weight in carbon dioxide. The amine process also requires a great deal of energy to recycle the fluids for further use. "It's a big energy sink," said Rice chemist James Tour, whose lab developed a technique last year to turn asphalt into a tough, sponge-like substance that could be used in place of amines to remove carbon dioxide from natural gas as it was pumped from ocean wellheads. Initial field tests in 2015 found that pressure at the wellhead made it possible for that asphalt material to adsorb, or soak up, 114 percent of its weight in carbon at ambient temperatures. Tour said the new, improved asphalt sorbent is made in two steps from a less expensive form of asphalt, which makes it more practical for industry. "This shows we can take the least expensive form of asphalt and make it into this very high surface area material to capture carbon dioxide," Tour said. "Before, we could only use a very expensive form of asphalt that was not readily available." The lab heated a common type asphalt known as Gilsonite at ambient pressure to eliminate unneeded organic molecules, and then heated it again in the presence of potassium hydroxide for about 20 minutes to synthesize oxygen-enhanced porous carbon with a surface area of 4,200 square meters per gram, much higher than that of the previous material. The Rice lab's initial asphalt-based porous carbon collected carbon dioxide from gas streams under pressure at the wellhead and released it when the pressure was released. The carbon dioxide could then be repurposed or pumped back underground while the porous carbon could be reused immediately. In the latest tests with its new material, Tours group showed its new sorbent could remove carbon dioxide at 54 bar pressure. One bar is roughly equal to atmospheric pressure at sea level, and the 54 bar measure in the latest experiments is characteristic of the pressure levels typically found at natural gas wellheads, Tour said.

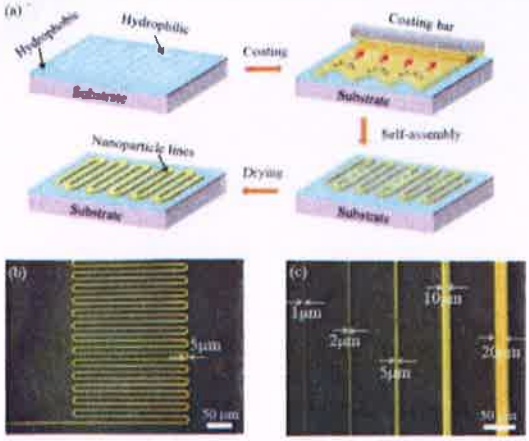
Source https://www.sciencedaily.com/releases/2016/09/160913125205.htm

5. Complex Materials Can Self-Organize into Circuits, May Form Basis for Multifunction Chips

Researchers studying the behaviour of nanoscale materials at the Department of Energy's Oak Ridge National Laboratory have uncovered remarkable behaviour that could advance microprocessors beyond today's silicon-based chips. The study shows that a single crystal complex oxide material, when confined to micro- and nanoscales, can act like a multi-component electrical circuit. This behaviour stems from an unusual feature of certain complex oxides called phase separation, in which tiny regions in the material exhibit vastly different electronic and magnetic properties. It means individual nanoscale regions in complex oxide materials can behave as self-organized circuit elements, which could support new multifunctional types of computing architectures. "Within a single piece of material, there are coexisting pockets of different magnetic and/or electronic behaviours," said ORNL's Zac Ward, the study's corresponding author. "What was interesting in this study was that we found we can use those phases to act like circuit elements. The fact that it is possible to also move these elements around offers the intriguing opportunity of creating rewritable circuitry in the material." Because the phases respond to both magnetic and electrical fields, the material can be controlled in multiple ways, which creates the possibility for new types of computer chips. "It's a new way of thinking about electronics, where you don't just have electrical fields switching off and on for your bits," Ward said. "This is not going for raw power. It's looking to explore completely different approaches towards multifunctional architectures where integration of multiple outside stimuli can be done in a single material." As the computing industry looks to move past the limits of silicon-based chips, the ORNL proof-of-principle experiment shows that phase separated materials could be a way beyond the "one-chip-fits-all" approach. Unlike a chip that performs only one role, a multifunctional chip could handle several inputs and outputs that are tailored to the needs of a specific application. "Typically you would need to link several different components together on a computer board if you wanted access to multiple outside senses," Ward said. "One big difference in our work is that we show certain complex materials already have these components built in, which may cut down on size and power requirements." The researchers demonstrated their approach on a material called LPCMO, but Ward notes that other phase-separated materials have different properties that engineers could tap into. "The new approach aims to increase performance by developing hardware around intended applications," he said. "This means that materials and architectures driving supercomputers, desktops, and smart phones, which each have very different needs, would no longer be forced to follow a one-chip-fits-all approach."

Source https://www.sciencedaily.com/releases/2016/09/160914130928.htm

6. Electronic Circuits Printed at One Micron Resolution



Formation of microcircuit lines using a selective coating technique. (a) Schematic of selective coating technique. Only a hydrophilic region created through irradiation of parallel vacuum ultraviolet (PVUV) is coated with metal ink. (b) Electronic circuit with a line width of 5 ?m formed through selective coating. (c) Electrode lines with different widths. Lines as narrow as 1 ?m can be formed.

A research team consisting of MANA Independent Scientist Takeo Minari, International Center for Materials Nanoarchitectonics (MANA), NIMS, and Colloidal Ink developed a printing technique for forming electronic circuits and thin-film transistors (TFTs) with line width and line spacing both being 1 μm. Using this technique, the research team formed fully-printed organic TFTs with a channel length of 1 μm on flexible substrates, and confirmed that the TFTs operate at a practical level. Printed electronics -- printing techniques to fabricate electronic devices using functional materials dissolved in ink -- is drawing much attention in recent years as a promising new method to create large-area semiconductor devices at low cost. Because these techniques enable the formation of electronic devices even on flexible substrates, they are expected to be applicable to new fields such as wearable devices. In comparison, conventional printing technologies allow the formation of circuits and devices with line widths only as narrow as several dozen micrometers. Accordingly, they are not applicable to the creation of minute devices suitable for practical use. Thus, there were high expectations for developing new printing techniques capable of consistently fabricating circuits with line widths of several micrometers or less. In this study, the research team developed a printing technique capable of forming metal circuits with line width being 1 μm on flexible substrates. Using this technique, they fabricated minute organic TFTs. The principle of this printing technique is as follows: First, form hydrophilic and hydrophobic micro-patterns on the substrate by irradiating it with parallel vacuum ultraviolet (PVUV) at a wavelength of 200 nm or less. Then, coat only the hydrophilic patterns with metal nanoparticle inks. The use of a PVUV light source (Ushio Inc.) enabled us to focus emitted light on much smaller targets than conventional light sources. Moreover, the use of DryCure-Au -- metal nanoparticle ink that can form a conductive film at room temperature developed by Colloidal Ink -- enabled us to form devices and circuits at room temperature during the entire process. As a result, they are able to fully prevent distortion of flexible substrates by heat, and form and laminate circuits within the accuracy of several microns. In addition, they precisely tuned the gate overlap lengths of the printed organic TFTs fabricated by this technique, which was previously impossible due to accuracy issues. As a result, a practical mobility level of 0.3 cm2 V-1 s-1 was accomplished for the organic TFTs with the channel length of 1 μm. In future studies, they will aim to apply the technique in various fields such as large-area flexible displays and sensors. Since the process developed is applicable to bio-related materials, the technique may also be useful in medical and bioelectronics fields.

Source https://www.sciencedaily.com/releases/2016/09/160901093000.htm

Aerospace Engineering

7. ISRO successfully launches INSAT-3DR from Satish Dhawan Space Centre

Scripting success on the maiden operational flight of its heavy-duty rocket fitted with the indigenous cryogenic upper stage, India on Sep 8, 2016 (Thursday) launched its advanced weather satellite INSAT-3DR onboard GSLV-F05 from the spaceport. The 49.13-metre tall rocket lifted off from the second launch pad at the Satish Dhawan Space Centre here at 4.50 pm, majestically soared into the skies and injected the 2,211-kg INSAT-3DR into a Geosynchronous Transfer Orbit about 17 minutes later. INSAT-3DR, with a designed mission life of ten years, will provide service continuity to earlier meteorological missions and further augment the capability to provide various meteorological, search and rescue services. The mission, the 10th flight of GSLV, assumes significance for the Indian Space Research Organisation (Isro) as it is the first operational flight of the rocket fitted with the indigenous cryogenic upper stage. Earlier, GSLV launches with indigenous cryogenic stage were under 'developmental' phase. GSLV-F05 also marked a hat-trick of success for the indigenously developed complex cryogenic upper stage (CUS) after GSLV-D5 (January 2014) and D6 (August 2015) missions, which had launched GSAT-14 and GSAT-6 satellites into precise orbit. The mission lifted the highest mass satellite. GSLV MKIII is going to lift the highest mass satellite on Indian soil in another three months. After the INSAT-3DR is placed in orbit, scientists at Master Control Facility at Hassan, Karnataka would perform the initial orbit raising manoeuvres and later place it in circular geostationary orbit. "This process may take place a few days after launch," the Isro official said. INSAT-3DR would supplement the services of INSAT-3D launched from French Guiana on 26 July, 2013. The payloads in INSAT-3DR are Imager, Sounder, Data-Relay Transponder and Satellite Aided Search and Rescue Transponder. The multi-spectral 'Imager' would generate images of earth every 26 minutes. It would provide information on various parameters, sea surface temperature, snow cover, cloud motion winds. It is an improved version of similar imager that was used on INSAT-3A and Kalpana-1 Satellites. The 'Sounder' payload, which was earlier used in INSAT-3D, will provide information on temperature and humidity. The Data-Relay Transponder would be used for receiving meteorological, hydrological and oceanographic data. The Satellite Aided Search and Rescue Transponder would pick up and relay alert signals originating from distress beacons of maritime, aviation, among others. INSAT-3DR would join INSAT-3A and INSAT-3D to provide operational search and rescue service.

Source http://www.firstpost.com/india/isro-successfully-launches-insat-3dr-from-satish-dhawan-space-centre-2996536.html

Mining, Metallurgical and Materials Engineering

8. Engineers Develop a Plastic Clothing Material that Cools the Skin

Stanford researchers began with a sheet of polyethylene and modified it with a series of chemical treatments, resulting in a cooling fabric.

Stanford engineers have developed a low-cost, plastic-based textile that, if woven into clothing, could cool your body far more efficiently than is possible with the natural or synthetic fabrics in clothes we wear today. The researchers suggest that this new family of fabrics could become the basis for garments that keep people cool in hot climates without air conditioning. "If you can cool the person rather than the building where they work or live, that will save energy," said Yi Cui, an associate professor of materials science and engineering and of photon science at Stanford. This new material works by allowing the body to discharge heat in two ways that would make the wearer feel nearly 4F cooler than if they wore cotton clothing. The material cools by letting perspiration evaporate through the material, something ordinary fabrics already do. But the Stanford material provides a second, revolutionary cooling mechanism: allowing heat that the body emits as infrared radiation to pass through the plastic textile. All objects, including our bodies, throw off heat in the form of infrared radiation, an invisible and benign wavelength of light. Blankets warm us by trapping infrared heat emissions close to the body. This thermal radiation escaping from our bodies is what makes us visible in the dark through night-vision goggles. "Forty to 60 percent of our body heat is dissipated as infrared radiation when we are sitting in an office," said Shanhui Fan, a professor of electrical engineering who specializes in photonics, which is the study of visible and invisible light. "But until now there has been little or no research on designing the thermal radiation characteristics of textiles." To develop their cooling textile, the Stanford researchers blended nanotechnology, photonics and chemistry to give polyethylene -- the clear, clingy plastic we use as kitchen wrap -- a number of characteristics desirable in clothing material: It allows thermal radiation, air and water vapour to pass right through, and it is opaque to visible light. The easiest attribute was allowing infrared radiation to pass through the material, because this is a characteristic of ordinary polyethylene food wrap. Of course, kitchen plastic is impervious to water and is see-through as well, rendering it useless as clothing. The Stanford researchers tackled these deficiencies one at a time. First, they found a variant of polyethylene commonly used in battery making that has a specific nanostructure that is opaque to visible light yet is transparent to infrared radiation, which could let body heat escape. This provided a base material that was opaque to visible light for the sake of modesty but thermally transparent for purposes of energy efficiency. They then modified the industrial polyethylene by treating it with benign chemicals to enable water vapour molecules to evaporate through nanopores in the plastic, said postdoctoral scholar and team member Po-Chun Hsu, allowing the plastic to breathe like a natural fiber. That success gave the researchers a single-sheet material that met their three basic criteria for a cooling fabric. To make this thin material more fabric-like, they created a three-ply version: two sheets of treated polyethylene separated by a cotton mesh for strength and thickness. To test the cooling potential of their three-ply construct versus a cotton fabric of comparable thickness, they placed a small swatch of each material on a surface that was as warm as bare skin and measured how much heat each material trapped. "Wearing anything traps some heat and makes the skin warmer," Fan said. "If dissipating thermal radiation were our only concern, then it would be best to wear nothing." The comparison showed that the cotton fabric made the skin surface 3.6 F warmer than their cooling textile. The researchers said this difference means that a person dressed in their new material might feel less inclined to turn on a fan or air conditioner. The researchers are continuing their work on several fronts, including adding more colours, textures and cloth-like characteristics to their material. Adapting a material already mass produced for the battery industry could make it easier to create products. Fan believes that this research opens up new avenues of inquiry to cool or heat things, passively, without the use of outside energy, by tuning materials to dissipate or trap infrared radiation.

Source https://www.sciencedaily.com/releases/2016/09/160901151933.htm

Energy Engineering

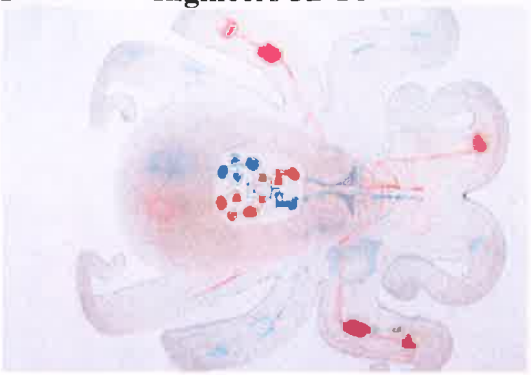
9. Engineers Design a New Solar Cell That is More Efficient and Costs Less

Engineers from MIT and the Masdar Institute of Science and Technology have developed a new solar cell that combines two different layers of sunlight-absorbing material to harvest a broader range of the sun's energy. A silicon solar cell with silicon-germanium filter using a step-cell design (large) and a gallium arsenide phosphide layer on silicon step-cell proof-of-concept solar cell (small).

The cost of solar power is beginning to reach price parity with cheaper fossil fuel-based electricity in many parts of the world, yet the clean energy source still accounts for just slightly more than 1 percent of the world's electricity mix. Solar, or photovoltaic (PV), cells, which convert sunlight into electrical energy, have a large role to play in boosting solar power generation globally, but researchers still face limitations to scaling up this technology. A team of researchers from MIT and the Masdar Institute of Science and Technology may have found a way around the seemingly intractable tradeoff between efficiency and cost. The team has developed a new solar cell that combines two different layers of sunlight-absorbing material to harvest a broader range of the sun's energy. The researchers call the device a "step cell," because the two layers are arranged in a stepwise fashion, with the lower layer jutting out beneath the upper layer, in order to expose both layers to incoming sunlight. Such layered, or "multijunction," solar cells are typically expensive to manufacture, but the researchers also used a novel, low-cost manufacturing process for their step cell. The team's step-cell concept can reach theoretical efficiencies above 40 percent and estimated practical efficiencies of 35 percent, prompting the team's principal investigators — Masdar Institute's Ammar Nayfeh, associate professor of electrical engineering and computer science, and MIT's Eugene Fitzgerald, the Merton C. Flemings-SMA Professor of Materials Science and Engineering — to plan a startup company to commercialize the promising solar cell. Fitzgerald thinks the step cells might be ready for the PV market within the next year or two. Traditional silicon crystalline solar cells, which have been suggested as the industry's gold standard in terms of efficiency for over a decade, are relatively cheap to manufacture, but they are not very efficient at converting sunlight into electricity. Silicon's low sunlight-to-electrical energy efficiency of 15 to 20 percent is partially due its bandgap; which prevents the semiconductor from efficiently converting higher-energy photons, such as those emitted by blue, green, and yellow light waves, into electrical energy. Instead, only the lower-energy photons, such as those emitted by the longer red light waves, are efficiently converted into electricity. To harness more of the sun's higher-energy photons, scientists have explored different semiconductor materials, such as gallium arsenide and gallium phosphide. While these semiconductors have reached higher efficiencies than silicon, the highest-efficiency solar cells have been made by layering different semiconductor materials on top of each other and fine-tuning them so that each can absorb a different slice of the electromagnetic spectrum. These layered solar cells can reach theoretical efficiencies upward of 50 percent, but their very high manufacturing costs have relegated their use to niche applications, such as on satellites, where high costs are less important than low weight and high efficiency. The Masdar Institute-MIT step cell, in contrast, can be manufactured at a fraction of the cost because a key component is fabricated on a substrate that can be reused. The device may thus help boost commercial applications of high-efficiency, multijunction solar cells at the industrial level. The step cell is made by layering a gallium arsenide phosphide-based solar cell, consisting of a semiconductor material that absorbs and efficiently converts higher-energy photons, on a low-cost silicon solar cell. The silicon layer is exposed, appearing like a bottom step. This intentional step design allows the top gallium arsenide phosphide (GaAsP) layer to absorb the high-energy photons (from blue, green, and yellow light) leaving the bottom silicon layer free to absorb lower-energy photons (from red light) not only transmitted through top layers but also from the entire visible light spectrum. The researchers conducted simulations based on experimental results to determine the optimal levels and geometrical configuration of the GaAsP layer on silicon to yield the highest efficiencies. The findings resulted in the team's initial proof-of-concept solar cell. On the MIT side, the team developed the GaAsP, which they did by growing the semiconductor alloy on a substrate made of silicon germanium (SiGe). The researchers believe the step cell fits well in the existing gap of the solar PV market, between the super high-efficiency and low-efficiency industrial applications.

Source http://scitechdaily.com/mit-engineers-design-a-new-solar-cell-that-is-more-efficient-and-costs-less/

10. SEAS Engineers 3D Print the First Autonomous, Entirely Soft Robot



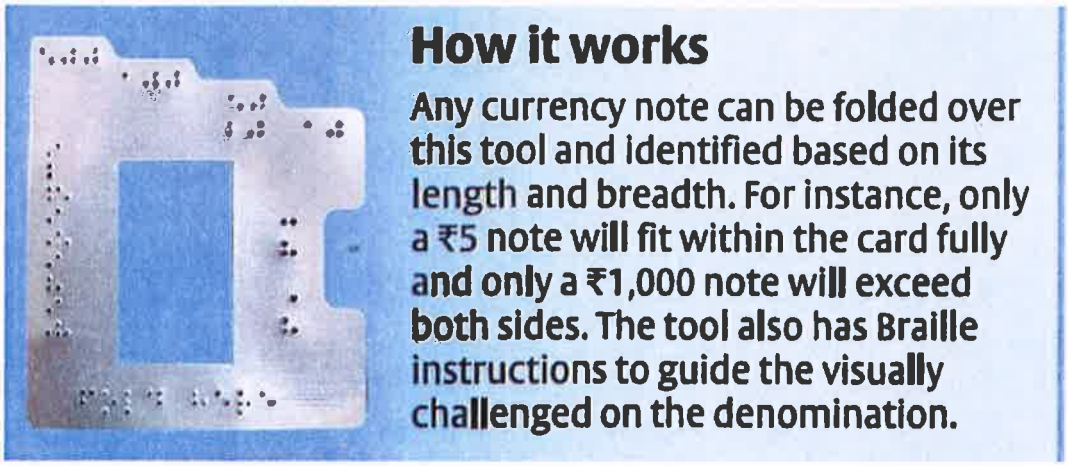
Using a 3D printer, Harvard engineers have demonstrated the first autonomous, untethered, entirely soft robot. The small robot — nicknamed the "octobot" — could pave the way for a new generation of such machines.

Soft robotics could help revolutionize how humans interact with machines. But researchers have struggled to build entirely compliant robots. Electric power and control systems — such as batteries and circuit boards — are rigid, and until now soft-bodied robots have been either tethered to an off-board system or rigged with hard components. Robert Wood, Professor of Engineering and Applied Sciences, and researchers conducted the research. "One longstanding vision for the field of soft robotics has been to create robots that are entirely soft, but the struggle has always been in replacing rigid components like batteries and electronic controls with analogous soft systems and then putting it all together," said Wood. "This research demonstrates that we can easily manufacture the key components of a simple, entirely soft robot, which lays the foundation for more complex designs." "Through our hybrid assembly approach, we were able to 3-D print each of the functional components required within the soft robot body, including the fuel storage, power, and actuation, in a rapid manner," said a researcher. "The octobot is a simple embodiment designed to demonstrate our integrated design and additive fabrication strategy for embedding autonomous functionality." Octopuses have long been a source of inspiration in soft robotics. These curious creatures can perform incredible feats of strength and dexterity with no internal skeleton. Harvard's octobot is pneumatic-based, and so is powered by gas under pressure. A reaction inside the bot transforms a small amount of liquid fuel (hydrogen peroxide) into a large amount of gas, which flows into the octobot's arms and inflates them like balloons. "Fuel sources for soft robots have always relied on some type of rigid components," said a researcher. "The wonderful thing about hydrogen peroxide is that a simple reaction between the chemical and a catalyst — in this case platinum — allows us to replace rigid power sources." To control the reaction, the team used a microfluidic logic circuit. The circuit, a soft analog of a simple electronic oscillator, controls when hydrogen peroxide decomposes to gas in the octobot. "The entire system is simple to fabricate. By combining three fabrication methods — soft lithography, molding, and 3D printing — we can quickly manufacture these devices," said a researcher. The simplicity of the assembly process paves the way for designs of greater complexity. Next, the Harvard team hopes to design an octobot that can crawl, swim, and interact with its environment. "This research is a proof of concept," researchers said. "We hope that our approach for creating autonomous soft robots inspires roboticists, material scientists, and researchers focused on advanced manufacturing."

Source http://scitechdaily.com/seas-engineers-3d-print-the-first-autonomous-entirely-soft-robot/

Engineering Innovation in India

This ₹2 Device Lets the Blind 'Read' Currency Notes



Every time Tiffany, 25, went shopping in Thiruvananthapuram, she ended up getting short-changed — literally. Shopkeepers who had no qualms about taking advantage of her visual disability would often slip her a ₹10 note and pass it off as a ₹20 note. When she complained about it to her Bengaluru-based friend and inventor Paul D'Souza, he came up with a solution. He designed a small credit card-like device made of PVC, with step-down edges on one side. By folding the notes over this tool, a visually challenged person can identify any Indian currency — thanks to differences in the length and breadth of notes of various denominations. For instance, if someone wants to confirm if he or she has been given a ₹10 or a ₹20 note (which have the same length but different width), they can fold the note against the device and check if it sticks out on the sides. If it does, it's a ₹20 note, which is wider. Besides, there are also instructions in braille markings on the device to guide the visually impaired. The ₹5 and ₹1,000 notes, however, don't fit the template. To dedicate the invention to his friend, D'Souza named the device 'Tiffy'. "The Tiffy template is a clever, original and practical device. The sheer simplicity of the tool is ingenious," says Ranganath Thota, founder of fueladream.com, a crowd-funding platform, which is currently raising funds to distribute the device free to the visually impaired. At just ₹2, the Tiffany template is a shining example of frugal innovation, but it's got more going for it. "It can help the visually impaired identify currencies much faster than smartphone apps designed for that purpose," says D'Souza. Most Indian currency notes have the same width, which renders it difficult for the visually impaired to tell them apart. While every note has a tactile marking that identifies the denomination, they tend to fade out over time with wear and tear. Last year, the RBI announced it would introduce ₹500 and ₹1,000 notes with enlarged identification markings along with bleed lines. "It's easy to identify if it's fresh off the mint," says D'Souza. "But it's harder with an old note that's been in circulation," he added. With five patents already to his credit, D'Souza is not filing a patent for the Tiffy template.

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