INDIAN NATIONAL ACADEMY OF ENGINEERING

E-Newsletter

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INAE VISION 2020-2025

INAE VISION

To be the premier Engineering Academy of the World providing timely inputs to the national and international policy makers, and to extend appropriate assistance in developing engineered solutions for the challenging problems facing contemporary societies and the humanity as a whole.

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INAE Mission

To serve professionals in building and institutionalizing engineering and technological excellence in education, research and industry in India and supports advancement of engineering profession globally

Technology Roadmap

We are living in exciting times. We will have to contend with the profound transformation of our society and our industry, because of two revolutions in the making – namely, the digital revolution and the impending transition to fossil fuel free energy globally.

The digital revolution is rapidly transforming the very nature of industrial enterprise today. Many disruptive transformations are maturing rapidly because of the advent of cloud computing and internet of things (IoT) and due to major advances and breakthroughs being made on several fronts such as artificial intelligence (AI) including machine learning (ML) and big data analytics, robotics, autonomy, drones, 3D printing, advance sensors and 5G technologies.

Another revolution in the making is the exciting possibility of fossil fuel-free generation of electricity in the coming decade. The availability of electricity based on renewable sources such as sun, wind and biomass, will cause a major disruption as well as an opportunity for creating a cleaner world, since use of fossil fuels (coal, oil or natural gas) currently, creates deleterious environmental consequences which need urgent attention.

While both these revolutions will cause major disruptions in how we live and work, the transition to the new world in the making is contingent upon the availability of new sources of critical raw materials.

Both digital hardware and generation of electricity from renewables (including the technological challenges associated with energy storage) require a host of new metals and materials for which the new value chains (also the appropriate global supply chains) will have to be established. Innovative processes for extraction of minerals and metals as well as recycling, which are more energy efficient and environment-friendly will have to be developed to produce these critical elements.

To facilitate this global transition, we need to create human resources with high level of domain expertise in different facets of engineering as well as the much needed engineering skill sets needed to deal with the problems of scalability, uncertainty, reliability, complexity, system engineering, ability to deal with variability and yet manufacture products and create solutions of uniform and reproducible quality, capability to design, develop and optimize engineering systems for a given set of inputs and for a desirable set of assured outputs of consistent quality.

Our engineering education has to be appropriately re-engineered so as to equip our future leaders with not only the domain expertise but also the skillsets to innovate continuously and consistently in the face

of constant change and dynamic transformations. The human ingenuity and the preparing the well-trained minds, will be critical ingredients in responding to the challenges ahead.

It in this context, INAE has come up with the following areas for our focused attention in the next five years. We believe that these efforts will assist us in facilitating the smooth transition to the new world in the making.

1. **Accelerated Discovery, Development and Deployment of Novel Materials, particularly for strategic sectors like Defense, Atomic Energy and Space.**

We have an urgent need of materials (metals, alloys as well as composites) development for the following sectors – auto sector (both electric vehicles as well as IC engines based vehicles), aerospace, ultra-supercritical power plants, nuclear power plants, renewable energy sector (novel PV materials, rare earth magnets, battery materials for both large scale energy storage as well as for electric vehicles and other electronic appliances, thermoelectric materials for converting low temperature heat into electricity), novel sensors for healthcare industry, materials for the defense applications and space applications, to name a few.

These materials will have to engineered for India-specific applications. That means one must consider during the process of design & development itself, the kind of natural resources we have and the kind of supply chains we will be able to establish to source the starting raw materials, considering the complex geo-political scenario and vulnerabilities associated with dependence on raw materials from abroad.

The other important consideration is the speed of development. In order to remain globally competitive in this domain, we must leverage the state of the art digital platforms (equipped with advance modeling, simulation, data analytics and knowledge engineering tools) for accelerating the development cycle from conception to deployment in actual applications as well as the entire life cycle (cradle to cradle or cradle to grave in some cases), that is, even for the structural health monitoring of the structures where these materials will be deployed.

Another important consideration is the environmental impact of these materials, that is, we must undertake a life cycle analysis, both with respect to the environmental footprint as well as the energy efficiency (actual consumption as compared to the thermodynamic energy needed to accomplish the particular task), for every developmental effort.

It is now well established that integrated computational materials engineering (ICME) approach can help accelerate the materials development cycle.

INAE will work towards coming up with a national strategy to establish and institutionalize the ICME based approach for all material development efforts. The digital platform, thus created, must be equipped with knowledge engineering capabilities so that it can not only act as a knowledge repository of all past efforts made thus far but also continues to update the knowledge going forward.

2. **Strategies for Energy Transition to Fossil Fuels free Renewable Energy Sources**

It is inevitable that India, like several other nations of the world, will move away from fossil fuels as a source of energy. While we have made some headway in developing renewable energy sources like solar and wind, the necessary infrastructure to support the energy transition does not exist at the present time. INAE plans to create an interdisciplinary expert group to study the whole energy transition comprehensively and holistically, keeping in mind the challenges inherent in such a massive transformation.

INAE will focus on the following important sectors which will be disrupted in the immediate future and/or the areas of concern which we require a strategy for, urgently to facilitate the transition

- Large scale energy storage solutions - Solutions other than Lithium Ion Batteries which do not seem to be appropriate for a country like India for a variety of reasons including the fact that we do not have the basic raw materials - Liquid Metal Flow batteries (for example, Vanadium Flow Batteries) is another attractive option which must be explored.
- Electricity Grid Infrastructure - current grid will not be able to cater to intermittent and distributed electricity inputs; the concept of smart grids which is adequately robust to cater to both supply side challenges (renewable energy sources) as well as demand management (dynamic pricing to take care of its peak loads).
- Transportation (electric mobility, both for people as well as for goods).
- Mining, Mineral Processing and Extractive Metallurgy Industry (which currently depends totally on fossil fuels not only as a source of heat but also as a reductant to convert metal oxides to metals).
- Recycling of waste by-products including municipal waste, tailings and smelter slags including steel slag, red mud and spent pot lining, electronic waste and hospital waste.
- Supply chains for raw materials needed for the transition - sourcing strategies from other geographies, urban mining, deep sea mining and space mining.
- Finding alternative technology options for the manufacture of steel and cement to reduce the environmental foot-print - currently these two materials which will continue to remain the backbone of the Indian economy for the foreseeable future and the consumption is likely to increase by an order of magnitude in the coming decade.
- Waste-water treatment and recycling.
- Water purification technologies including desalination

3. Excellence in Engineering Education

Several groups including other academies globally, are working on the new curricula for engineering education so that our young emerging leaders are adequately equipped with necessary engineering skill sets to face the challenges in the coming decades.

Various deliberations within India as well as abroad have emphasised the need of providing hands-on design experience, problem solving skills and exposure to the systems engineering concepts, tools and technologies to the engineering students. The curricula also need to be updated with the advancements in digital technologies.

All engineers must be familiar with the sustainability paradigm and must be able to do life cycle analysis for every engineering product. They must be equipped with knowledge and the experience with various digital platforms and modelling tools such as computational materials engineering (all the way from atomistic scale to macroscopic scale), computational fluid dynamics, structural analysis tools, life cycle analysis modelling tools, engineering scale up, robust design methodologies to take care of uncertainty and complexity, machine learning and data analytics tools and algorithms, multi-objective and multi-variate optimization tools and technologies.

It is important that the professional ethics is part of the engineering course curricula. A multi-disciplinary systems perspective to all engineers will certainly broaden their horizons – much needed to face the emerging world scenario. Good communication skills and ability to work in teams, are also prerequisites for engineers to succeed in the real life.

All engineers must possess basic IT skillsets and it is a given since digital technologies are transforming every aspect of our lives.

A multidisciplinary INAE Expert Group will critically examine the current status of engineering education, identify gap areas and strive to fill those gaps with appropriate action plans

4. World Class Infrastructure

INAE will come up with an action plan in consultation with all stake- holders to upgrade our national infrastructure within next few years. This will include

- Requirements, technology options and the investments needed to create a few smart cities in the country - including mobility, healthcare facilities, e-governance, access to affordable housing, utilities (electricity and water), waste collection, processing and recycle, education, communication, maintenance of infrastructural facilities, disaster management infrastructure including extreme events (for example, excessive rain and floods) etc.
- Requirements, technology options and the investments needed to create a rural infrastructure so that they can enjoy access to certain basic amenities where they are located - digital connectivity for example can provide them with access to healthcare, online education, information dissemination, financial inclusion, logistics warehousing and agriculture and farm productivity with engineering focus etc.

5. Cyber-physical Systems

Globally innovations are taking place at the interface of digital technologies and domain expertise. For example, manufacturing is being transformed as a consequence of the following - robotics and automation, Internet of Things (IoT), cloud computing, 3D printing, AI, machine learning and data analytics (Digital Twins), structural health monitoring of built structures and engineered products, drones, autonomy, data analytics based predictive asset maintenance systems, blockchain technology to facilitate complete traceability of the products, digital platforms for integrated design, development, deployment and monitoring of materials and products and knowledge engineering platforms for capturing, retaining and context sensitive retrieval of knowledge to solve challenging problems.

Similarly leveraging the advanced digital technologies, the infrastructure available in a given locality or a city can be upgraded for easy accessibility – for example, healthcare facilities, e-governance, utilities (electricity and water)

It is now possible to make most of healthcare facilities available to the citizens at their place ofresidence (particularly important for senior citizens living alone) through the intervention of digital connectivity, sensors and IoT solutions. Provision of healthcare and affordable Medicare facilities through technological interventions is a key focus area.

INAE will select certain areas for focussed attention during the next five years and develop strategies to create infrastructure to facilitate digital transformation for achieving a set of desirable objectives for example, higher productivity, higher efficiency, better quality of life and better quality of products, reduced cost of services, higher safety of workers, etc.

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ACADEMY ACTIVITIES

Academy News

INAE Announcements

- **Invitation of Nominations for Fellowship is open.** Fellows may submit nominations though log-in facility provided by INAE Digital Platform. Last date of receipt of nominations: **March 31, 2021.** For details click on the link given below.

  Link for Fellowship

- **Invitation of Nominations for INAE Young Engineer Award is open.** Last date of receipt of nominations: **March 31, 2021.** For details click on the link given below.

  Link for Young Engineer Award

AICTE- INAE Distinguished Visiting Professorship Scheme Committee Meeting

AICTE- INAE Distinguished Visiting Professorship Scheme Committee meeting was held on February 12, 2021 to deliberate on new nominations received under the scheme and review performance of the existing Distinguished Visiting Professors. INAE received 53 fresh nominations of Industry / R&D experts under the scheme in response to advertisement published by AICTE for academic year 2021-22. The Committee reviewed and deliberated on all the nominations and 7 candidates were selected and 5 nominations were shortlisted.

The MoU on AICTE-INAE DVP Scheme was renewed on November 11, 2020 where the number of selections of Distinguished Visiting Professors has been limited to 15 every year. Based on the MoU statement, the 5 shortlisted nominations have been put up to AICTE for approval.

Since the scheme is extended to retired INAE Fellows, applications were invited from INAE Fellowship. 12 applications were received from retired INAE Fellows which were discussed and 7 applications were selected based on the laid down criteria. The names are as given below:

(a) Dr. Rabindra Nath Ghosh, Mining, ES-VIII (Mining, Metallurgical and Materials Engineering)
(b) Mr. Ajay Narayan Deshpande, ES-IV (Chemical Engineering)
(c) Prof. Rajendra Prasad Chhabra, ES-IV (Chemical Engineering)
(d) Dr. Ram Kumar Singh, ES-IX (Energy Engineering)
(e) Prof. Malay Kumar Kundu, ES-II (Computer Engineering and Information Technology)
(f) Dr. Debabrata Das, ES-IX (Energy Engineering)
(g) Dr. C. V. Rode, ES- IV (Chemical Engineering)

Existing guidelines were also reviewed and changes suggested on request for change of college of association and minimum eligible age for application under the scheme.

INAE Webinar Series

INAE Kolkata Chapter

INAE Kolkata Chapter organized the National Science Day Lecture – A Talk on **"Individual Atoms as Clocks and Bits"** which was delivered by **Professor David J. Wineland**, Nobel Laureate in Physics 2012 University of Oregon, USA on **28th February 2021 (Sunday Morning) at 09:45 hrs. (IST)** through WebEx Platform on the occasion of celebrating the National Science Day. Prof. Indranil Manna, President, Indian National Academy of Engineering (INAE) presided over the event which was Moderated by Prof. Debatosh Guha, FNAE, Professor, Institute of Radio Physics and Electronics University of Calcutta.

INAE Mumbai Chapter

INAE Mumbai Chapter organised a webinar on **High Intensity Super Conducting Proton Accelerators (HISPA): Challenges and Achievements** on 17th Dec 2020. At the beginning of the talk, the subject was introduced by Dr. Ajit Kumar Mohanty, Director, Bhabha Atomic Research Centre (BARC). The webinar was delivered by Dr. Srinivas Krishnagopal, Head, Ion Accelerator Development Division BARC. The session was moderated by Dr. R. B. Grover, Co-convener, INAE Mumbai Chapter, Emeritus Professor HBNI.

The Large Hadron Collider (LHC) at CERN is an example of a high ***energy*** superconducting proton accelerator. The next frontier is the high ***intensity*** frontier. A High Intensity Superconducting Proton Accelerator (HISPA) would have an intensity (or proton current) an order of magnitude greater than the LHC.

HISPA has a number of important societal and discovery science applications: (i) energy security through Accelerator-Driven Reactor Systems (ADS) that can be used to breed thorium; (ii) for medical applications through the production of radio-isotopes for cancer therapy and medical imaging; (iii) production of Radio-active Ion Beams (RIB) for discovery science in nuclear physics; (iv) neutrino production for discovery science in high-energy physics; (v) Spallation Neutron Sources (SNS) for basic and applied research in a wide variety of fields.

There are many scientific and technological challenges in building such a high intensity accelerator. The high intensity of protons results in nonlinear motion of the particles, which is difficult to study, but essential because it can lead to the formation of *beam halos.* These halos can lead to loss of high energy particles from the accelerator, which can turn the surroundings radioactive; hence the halos must be well studied and controlled. The high intensity also requires very careful design to ensure complete control of the proton beam, to ensure reliable operation of the accelerator. The superconducting accelerator requires a large and complex cryogenics system that allow the accelerator to operate at -271 °C! Finally, for maximal use of the accelerator it has to be operated in a continuous mode (CW mode) which is so challenging that no country has yet succeeded, though there are very serious CW HIPSA projects in the US and China.

For the applications described above, India has taken HISPA technology very seriously. In any proton accelerator, the low energy part (up to around 10 MeV) is the most critical. Therefore, as a first step, the Bhabha Atomic Research Centre (BARC), Mumbai, took up the development of a Low Energy High Intensity Proton Accelerator (LEHIPA), which will accelerate a 10-mA proton beam to 20 MeV. After ascending a steep learning and technology curve, protons were accelerated to 3 MeV in 2019, using a four-vane Radio-Frequency Quadrupole (RFQ), and are poised reach first 10 MeV and then 20 MeV later this year. The centrepiece of LEHIPA is the successful development of the RFQ, which is perhaps the most difficult accelerator component in HISPA. The RFQ is made in four sections of length 1 m

each. Each section has four vanes made of oxygen-free copper, that have been machined to tolerances of better than 50 μm, over the length of 1 m. The four sections have been aligned together to within tolerances of around 150 μm. Total RF power of around 600 kW was fed to the RFQ to achieve acceleration to 3 MeV. Other important technologies that have been mastered in LEHIPA include RF couplers, high power RF systems, low-level RF electronics, high voltage power supplies, control systems, etc. It is a matter of pride to note that almost every component in LEHIPA has been designed and developed indigenously, demonstrating largely self-reliant in this technology.

As a second step towards HIPSA technology, the Department of Atomic Energy has entered into an 'Indian Institutions and Fermilab Collaboration' (IIFC), with the Fermi National Accelerator Laboratory (Fermilab), USA, for hastening the development of superconducting accelerator technology in the country. Fermilab is interested in HISPA for neutrino applications and is build a 700 MeV HIPSA. India is participating in almost every aspect of the R&D for this accelerator. In return, Fermilab is making available to us all HIPSA technology developed by them. In addition, Indian scientists and engineers are also hosted by Fermilab for 1-2 years each, and over 15 persons have already been trained in this manner. Through this Collaboration India has designed and developed different superconducting cavities required for HISPA, as well as RF amplifiers, magnets, low-level RF systems, etc. - some of these systems are already working successfully at Fermilab. Thus, a large number of scientists and engineers have been working on HISPA technology for many years and are now quite well advanced in the field.

In order to energise the national HISPA programme, and to leverage the gains from IIFC, BARC now proposes to build a HISPA accelerator at its new campus at Visakhapatnam. This will likely be a 200 MeV, multi-purpose HISPA, that can be used for RIB, radio-isotope production, etc., and in the future can be extended to 1 GeV and used for ADS. The future of HISPA in India is both bright and intense!

Link for recording of webinar: https://www.youtube.com/watch?v=WBNtEDnOKBs

INAE Mumbai Chapter organized a webinar on "**Implications of NEP-2020 for Engineering Education in India**" on **16th February 2021.** The Session was Moderated by **Prof A K Suresh, FNAE, Co-Convener - INAE Mumbai Chapter, and Professor - Department of Chemical Engineering, IIT Bombay and the S**peaker for the session was **Prof Raghunath K Shevgaonkar, FNAE, Emeritus Professor, IIT Bombay**

Abstract: After 34 years, Indian Government approved new National Education Policy, NEP-2020. Broadly, the policy has received appreciation from all sectors of education. The policy has proposed many radical changes in Indian education system. It has proposed simplified regulatory structure with more flexibility in programs and curricula. The policy has put ample thrust on multi-disciplinary education with substantial component of liberal arts in higher education. Although there is no special treatment for engineering education in NEP-2020, many of the general proposed reforms may impact engineering education in India. The NEP-2020 is forward looking but the real challenge lies in its implementation. The talk critically looked at various aspects of NEP-2020 and its impact on technical education as a whole.

Bio-Data of speaker: Prof. Raghunath K. Shevgaonkar, Professor Emeritus, IIT Bombay

Dr. Shevgaonkar has been an active researcher in the area of Electromagnetics, Optical communication, Image processing, Antennas, Microwaves, Radio astronomy etc. He has extensively published in international journals and conferences, and authored a textbook namely Electromagnetic Waves, and a monograph on Transmission lines for Electrical Engineers with McGraw Hill Education.

He has occupied many academic leadership positions like Director IIT Delhi, Vice Chancellor of University of Pune, Vice Chancellor of Bennett University, and Deputy Director, Dean Resource Mobilization, Dean Student Affairs, Head Department of Electrical Engineering, Founder Head of Centre of Distance Engineering Education Program etc., at IIT Bombay. He is a Fellow of IEEE, Indian National Academy of Engineering, National Academy of Science, India, Institution of Electronics and Telecommunication Engineers, Optical Society of India, Institution of Engineers, Maharashtra Academy of Sciences, and Member of International Astronomical Union and Astronomical Society of India.

He is a recipient of IEEE William E. Sayle Award for his Achievements in Engineering Education, IEEE Undergraduate Teaching Award for his inspirational teaching, SN Mitra Memorial Award of Indian National Academy of Engineering for his contribution to electromagnetics, antenna and radio astronomy, Ram Lal Wadhwa Award of IETE for his outstanding contribution to Optical communication, VASVIK Award in ICT, and the 'Excellence in Teaching' award of IIT Bombay. He has received the Education Leadership Award from Headlines Today, and Dewang Mehta Educational Excellence Award.

INAE Bangalore Chapter

INAE Bangalore Chapter organized a Webinar talk by Dr. Ravishankar Krishnaswamy, Principal Researcher, Microsoft Research India on **"Recent Algorithms and Systems for Nearest Neighbour Search"** on December 24, 2020. The talk was given by Dr. Ravishankar, Microsoft Research, who is an INAE Young Engineer Awardee. It focused on deep learning-based embeddings, which are used in application domains such as information retrieval and computer vision owing to their ability to capture diverse types of semantic information between the different entities in a dataset. It focused on a fundamental challenge that arises in fully realizing the potential of these embeddings, which is efficiently retrieving the approximate closest vectors to any given query vector from the vectors of the base dataset. The talk described approximate nearest-neighbour search (ANNS) and gave details of the type of techniques that can be used to build efficient scalable systems for this fundamental computational problem.

Link for recording of webinar: https://www.youtube.com/watch?v=wosxmwL-MAc&t=9s

INAE Bangalore Chapter organized a Webinar talk by Mr. S. Narender, Defence Research and Development Laboratory on **"Thermo-Structural Testing of One-to-One Aerospace Structures using Infrared Heating"** on November 26, 2020. The talk was given by Mr. Narender, DRDO, who is an INAE Young Engineering Awardee. The talk focussed on aerodynamic heating in Aerospace vehicles like missile and space systems, which fly at high Mach numbers. The talk discussed about creating an environment on the ground to simulate close to the actual flight conditions. This is needed so that the designed airframe can be structurally qualified prior to the actual flight. The generation of controlled time-varying temperature/heat flux and pressure/structural loads on airframe sections using short-wave infra-red heating as discussed. The talk was attended by 30 people. It was followed by a lively question and answer session.

Link for recording of webinar: https://www.youtube.com/watch?v=v_1zUMFDeL8

INAE Bangalore Chapter organized a webinar talk by Prof. M. L. Munjal, FNAE and Professor, IISc, Bangalore -on January 28, 2021 on **"Controlling Urban Environment Noise through Mandatory Noise Limits".** He headed the National Committee for Noise Pollution Control (NCNPC), which has been issuing Gazette Notifications prescribing noise limits as well as rules for regulation and control of noise pollution in the urban environment, right from its inception in 1997 for 18 years. He touched upon noise pollution (regulation and control) rules, permissible noise exposure for industrial workers, and

noise limits for diesel generator sets, portable gensets, noise firecrackers, and vehicles. The talk was attended by 35 people. It attracted a large number of diverse questions from the audience.

The fourth INAE-BC webinar was given by Prof. K.G. Ranga Raju on February 18, 2021. His talk titled "**River Water Disputes**" provided a fascinating perspective on river water disputes. It brought out the societal implications of engineering and how it is interlinked with several other aspects. Prof. Ranga Raju pointed out that the resolution of these disputes required addressing political sentiments, legal aspects, technical issues, and treaty requirements. As examples, he discussed three disputes in which he was personally involved, namely, Varuna Canal (Mysore and Mandya districts), Krishna Basin (Karnataka, Maharashtra, and AP), and Baglihar Dam (India and Pakistan). These disputes were at the state level, national level, and international level, respectively.

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. R Vijayarajeswaran Managing Director, VI Microsystems Pvt. Ltd, Perungudi, Chennai	Sri Muthukumaran Institute of Technology, Chennai Jul 17, 24, 31, 2020, Aug 7, 17, 21, 28-2020 and Sept 4, 13, 2020	Delivered lectures on "Introduction to Embedded computing and ARM processor", Embedded system design process", "ARM processor architecture", "Instruction set preliminaries", "ARM Programming Styles", "Embedded Linux on ARM", "Designing with computing platforms", "Models of Program", "Compilation Techniques", "Software performance optimization", "Embedded C Basic Concepts, programming styles", "PIC based platform for microcontroller programming", "Examples of Embedded C programming", "Introduction about processes and operating systems", "Multiple tasks and multiple processes", "Pre-emptive real time operating system", "Linux system - commands tools, editors", "Examples with Embedded Linux programming", Arduino programming basics", "Arduino function libraries", "Python programming concepts", " Raspberry Pi programming with examples", "Arduino Advanced", "Examples with Arduino programming" Given assistance in students projects and helped in developing prototype to product, development of new courses and arranging industry institute linked activities.

Dr. Lalit Kumar Chairman CEPTAM, DRDO, New Delhi; Director (Retd), MTRDC, DRDO, Bangalore.	Dayananda Sagar Academy of Technology & Management, Bangalore Dec 18, 19, 21, 2020 Dec 31, 2020 and Jan 1-2, 2021	Delivered Lectures on "Introduction to microwaves and applications", "Klystron Tubes", "Transmission Lines" According to the feedback received from the institution this scheme created a platform where industry, academia, and government organisations exchange information. During this first event, several topics related to microwave engineering are presented with respect to academia and industry. Delivered Lectures on "Maxwell's Equation", "Displacement and conduction current, "Derivation of Maxwell's equation in point and integral form" As per the feedback received from the institution the Scheme enable students to understand the concepts clearly and skills of students gets improved. Learning beyond the curriculum helps students to explore their research knowledge.
Prof. Ganapati Panda, FNAE Former Deputy Director & Prof. School of Electrical Sciences, IIT Bhubaneswar, Research Advisor for CV Raman College of Engineering, Bhubaneswar, Odisha	BVRIT Hyderabad college of Engineering for Women, Bachupally, Hyderabad Jan 1-2, 2021	Delivered lectures on "How to write good research article and proposal", "How to get funding from agencies" As per the feedback received from the institution, teaching faculty and PhD scholars in the college were benefited by his lectures directly. His involvement in making the scholars understand the various aspects of publishing and fetching funds through research projects supported to meet the goal of the R&D of the institution. The institution is fortunate to be a part of this scheme.
Dr. D. Antony Louis Piriyakumar Director-Startup, Agape Piriyakumar AI Solutions, Bengalore	Thiagarajar College of Engineering, Madurai Jan 20-22, 2021	Delivered lectures on "Introduction to Data Structures", "Fundamentals of Patents", "Patent Search", "Patent Landscape", "Deep learning", "Python Programming Part - I" As per the feedback received from the college, the webinar on patents has paved a way to easily understand the process of IPR among the faculty members and research scholars. The institute has started a lecture series on Python programming, data structures and deep learning. These topics are very important for research scholars, faculty members and UG and PG students to update their research.

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International/National Conferences/Seminars being Organized By IITs/other Institutions

International Conference on Current Trends in Materials Science and Engineering on 11th to 13th March 2021 being held online from Kolkata
https://conferencealerts.com/show-event?id=231002

International Conference on "Advancements and Innovations in Civil Engineering" (IC-AICE-2021) on18th to 20th March 2021 being held online from Nagpur
https://conferencealerts.com/show-event?id=232361

9th International Conference on Contemporary Engineering and Technology 2021 Conference on 20th to 21st March 2021 being held online from Chennai,
https://conferencealerts.com/show-event?id=232291

Note: Due to Lockdowns imposed by Government in view of Covid-19, schedule of these conferences may be rechecked.

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News of Fellows

1	Mr VK Agarwal, FNAE, Formerly Chairman, Railway Board & Ex-officio Principal Secretary, Govt. of India has authored an IEI Centenary Monograph on 'Survival of Planet Earth: Scientifico-Spiritual Analysis', published under the aegis of Interdisciplinary Engineering. The monograph may be accessed using the link: https://www.ieindia.org/webui/ajax/Downloads/WebUI_PDF/Publication/Monograph.pdf?v.20210204.1 Mr VK Agarwal is author of one of the lead articles on "Role of Engineers in Policy Making" in IEI Centenary Book titled "Engineering for the Future". The article may be viewed by clicking here
2	Dr RK Bhandari, FNAE, Formerly Director, Central Building Research Institute, Roorkee & Programme Director, UN-HABITAT, Nairobi; Formerly Chairman, Centre for Disaster Mitigation and Management, VIT, Vellore Participated in A Webinar as Expert of The Day, Organized by National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Govt. Of India on "Risk to Resilience: A Dialogue with Dr RK Bhandari" on February 16, 2021.
3	Prof SN Mukhopadhyay, FNAE, Adjunct Professor, Department of Biological Sciences, BITS, Pilani and Former Professor, DBEB, IIT Delhi; Former Professor & Head, BERC, IIT Delhi; Former Professor SOBT, GBU, Greater Noida, U on invitation sent abstract of his invited lecture on title "In vitro, in situ, in vivo and de novo Membrane Assisted Bioprocesses" which has been accepted to be delivered in ICMMAP-2021 to be held between Feb 12 to 14, 2021 in MGU, Kottayam, Kerala. His paper titled "Food Packaging: Fundamentals and Advances" was accepted by Journal of Food Science and Engineering. Also, he had delivered IL54 in ICMMAP 2021 on 13 Feb.2021 which was held in MGU, Kottyam, Kerala

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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/inaehq1

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

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OBITUARIES

Dr Narayanan Lakshmanan
(12 November 1946 – 2 February 2021)

Dr. Narayanan Lakshmanan, FNAE, Former Director of Structural Engineering Research Center (SERC), CSIR, Chennai, passed away to eternal abode at about 9.00 am on 2nd Feb. 2021 at his house in Periyar Nagar, Chennai. He did his B.E.(Civil) degree from the Alagappa Chettiar Government College of Engineering & Technology (ACCET), Karaikudi, Madras University and earned M. Tech and Ph.D. degrees in Structures from the Indian Institute of Technology, Madras. His Ph.D. guide was (Late) Prof. D.J. Victor, who has written the popular text book on Bridge Engineering.

He started his professional experience as an Associate Lecturer at IIT Madras (1970 – 75). He then joined SERC as Scientist in 1975 and rose to become its Director in June 01 and held it till Nov. 2008. During this period, he also held the post of Coordinating Director, CSIR- CMC. From Jan 09 to April 2012 he was a National Project Advisor of CSIR.

He was a scientist par excellence and a very eminent structural engineer and acted as advisor to government bodies in Tamil Nadu and India. He was a member of several professional bodies. Dr. NL was a very nice human being and was approachable to all his peers, juniors, and contemporaries irrespective of the positions he occupied in his life.

He had guided/co-guided for scientist of CSIR-SERC for doctoral degrees, Seven for Post Graduate Research and three students for INAE mentorship program. He had been the backbone of SERC from the time he joined there in 1975 and had been its strong pillar till the end.

He led the creation of State-of-the-Art world class test facilities-The Structural Dynamics Laboratory for planning, analysis, design and construction of the pile-supported medium duty floor; Tower Testing and Research Station (opposite to Chennai Airport) for planning, design and construction of heavy duty structures; Fatigue Testing Laboratory; setting up of wind engineering laboratory with an open ended Atmospheric Boundary Layer Wind Tunnel Test Facility (ABLWT) for studying the effects of cyclones; Advanced Seismic Test Facility, and construction of various other labs in SERC, Chennai, and his studies on structures in cyclone prone areas stand as an proof of his excellence.

He had contributed 175 International / National Journal Papers, 250 International/National Seminar Papers and 285 Tech. Reports: R&D Reports, and 134 Consultancy Reports which are well acknowledged and cited in India and abroad. In addition, he had contributed 9 Scientific books and filed 2 patents. He collaborated with eminent engineers in India and abroad during the past 5 decades and made solid contributions to the field of Civil and Structural Engineering in India.

He received several Awards and Distinctions (including fellowships of the learned societies) for his significant contribution in the field Civil Engineering, some of them are as follows:

1. Elected as Fellow of the Indian National Academy of Engineering (Civil Engineering) in 2003
2. Elected as Fellow of the Institution of Engineers (India) (Civil Engineering) in 1999
3. Received the Engineering Technology Shield of CSIR, New Delhi for Mitigating Damage due to Cyclones in 2000.
4. A.S. Arya – University of Roorkee Award for Wind Engineering and Cyclone Disaster Mitigation in 2000.
5. Outstanding Concrete Engineer of Tamil Nadu by the Indian Concrete Institute For overall contribution in concrete technology in 2008.

6. Life time achievement of award of the Indian Society of Wind Engineering For outstanding contribution in the field of Wind engineering in India in 2013 and the
7. Life time achievement Award of the Indian Concrete Institute For his contributions in the field of Concrete structures in 2018.

He was also the Chairman of the Structural Safety Sectional Committee, CED 37, in addition to being a member of various other committees of Bureau of Indian Standards.

With red vermillion on his forehead and a warm smile on his face, he was always distinct and made his mark in the audience around him with his friendly nature. Dr. NL was a man down to earth and connected with everyone and known for his warmth and humaneness. He was adored and loved by all his associates, all of whom will miss him dearly. He left behind his wife Dr Gomathy Lakshmanan, his mother, his sons, daughter in law, granddaughters.

It is a great loss to me, as we were together at IITM, when I did my Ph.D. I still remember the jokes and other experiences shared with him during that time. I wish to convey our heartfelt condolences to his family and friends and pray the almighty to grant blessings in heaven to this noble soul.

Written by Dr. N. Subramanian, FNAE

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When a very close associate, colleague, and a real friend finally departs, one is often stunned and speechless. I too was badly shaken up by the news of the untimely demise of Dr. N. Lakshmanan (NL), my mentor, and a former Director of CSIR-Structural Engineering Centre. He passed away in the morning of Tuesday, the 2nd February 2021 in Chennai, leaving behind his foot prints as an outstanding teacher, a world-class researcher, a dynamic leader, and an Institution builder. In him, I lost a dear friend, philosopher and Guide and the nation lost an outstanding engineer committed to serve his chosen profession with the best of his abilities. My wife Seetha and I would like to join his thousands of colleagues, friends and admirers, in paying our collective heartfelt tributes, homage and condolences to the bereaved family, especially to his wife, Dr. Gomathy and his two sons, Narayanan and Krishnan and the daughters-in-law.

NL will always be admired and remembered for his scientific acumen, breadth and depth of knowledge, matured analytical thinking and his deep sense of commitment to the service of the nation. His unpretentious life style often made it hard for the first timers to fathom out his true virtues. He was a very kind hearted human being-unassuming, simple, and full of empathy so much so that he hardly said “no” to the genuine requests working his way through the rule book. This is how he could build Teams throughout his professional career.

NL obtained his bachelor’s degree in Civil Engineering from ACCET, Karaikudi, Madras University in 1968; the postgraduate degree (1970) and the doctoral degree (1979) in Structural Engineering from IIT Madras. While pursuing his doctoral program at IIT Madras, he also taught as Associate Lecturer at the IIT Madras from 1970 to 1975. Recognizing his merit, Professor G.S. Ramswamy, the founding Director of CSIR-SERC offered to join SERC as a Scientist. At that time, no one would have even imagined that a future Director of SERC was being appointed! In June 2001, NL, took over the charge Director, CSIR-SERC. After he attained the age of 60, his performance was so outstanding that his term as the Director of SERC was extended by two years, until November 2008. Thereafter, he served as a National Project Director at CSIR from January 2009 to April 2012. I feel singularly fortunate to have succeeded him as the Director of CSIR-SERC.

Creation of many world class test facilities at SERC became one of his dreams which he passionately pursued. The Structural Dynamics Laboratory for planning, analysis, design and construction of the pile-supported medium duty floor; Tower Testing and Research Station for planning, design and construction of heavy duty structures; Fatigue Testing Laboratory; Atmospheric Boundary Layer Wind Tunnel Test Facility; Advanced Seismic Test Facility etc. were the outcome of the ongoing projects he inherited and the new projects he initiated. His professional interests extended well beyond the boundaries of his primary areas of his professional expertise in structural concrete, materials of construction, and structures subjected to extreme (dynamical) loads, wind or earthquake or blast. The wind map of India; the Vulnerability Atlas of India; the earthquake zoning of India, Cyclone shelters, Wind Engineering and Wind Tunnel Testing facilities all carry his stamp of contribution. Many scientists of CSIR-SERC who obtained Post Graduate Research and doctoral degrees from premier institutions, and many students who went through the INAE mentorship program recall him with gratitude as their mentor

NL captured attention of the Indian National Academy of Engineering when his help was sought to further the idea of establishing National Disaster Knowledge Nework mooted by Dr R.K. Bhandari and supported by Dr Anil Kakodkar, the then President of INAE and Shri J.C. Pant, the Chairman of the High Powered Committee on Disaster Management appointed by the Government of India. Research Council of SERC accorded its approval to establishing a Knowledge Network Centre at SERC at its 25th meeting held on 10 November 2000. Soon thereafter, he was elected as a Fellow of the National Academy of Engineering in 2003. In the same year, he took the lead in hosting a Roundtable Meeting at SERC to give impetus to Seismic Micro zonation in India. The roundtable meeting held under the aegis of INAE was Chaired by Dr A. Ramakrishna on 24 February 2003 in which the backgrounder authored by Dr R.K. Bhandari was discussed. The recommendations of the roundtable meeting submitted to the Department of Science and Technology provided direction to the national seismic micro zonation initiative.

The accolades, awards, rewards, and recognitions followed NL as his shadow. At the dawn of the new millennium, in the year 2000, he received the CSIR Engineering Technology Shield for Engineering of Structures for Mitigating Damage due to Cyclones. The same year he received A.S. Arya – University of Roorkee Award for Wind Engineering and Cyclone Disaster Mitigation. For overall contribution in concrete technology, the Indian Concrete Institute of Tamil Nadu Chapter recognized him as - Outstanding Concrete Engineer of Tamil Nadu in 2008. For the impact of his professional contributions in the field of Wind engineering in India, the Indian Society of Wind Engineering, in 2013, conferred on him the Life Time Achievement award. A few years later, in 2018, the Indian Concrete Institute too conferred on him the Life Time Achievement award for contributions in the field of Concrete structures.

I came in close contact with NL in 1978 when, after the day's work, we both had to daily walk about 4 km from the SERC campus to the nearest bus stop on way back home. Providence brought us together to work on several projects and programs, thanks to Dr. Narayanan, then heading the Experimental Mechanics Laboratory. We both served the staff club of SERC together when he became its Vice-President and I became its Secretary. We played cricket together. He, as an inquisitive student, watched the game very fondly and thereafter, analyzed every aspect of the game, the tests, the T20s, and the one-dayers! Our shared professional interests brought us even closer with the passage of time. When NL became the Director of SERC, his trust in me was so profound that he asked me to serve not only as Advisor (Management), but also on several other committees and assignments.

NL used to tell me in the Tamil language that- you are my younger brother- pointing out the providential gift of common date and month of birth blessed with identical astrological stars in the traditional Hindu panchang!

He has gone from our sight, but will never, ever from our memories. He has gone from our touch, but will never, ever from our hearts. Our deepest condolences!
May His Soul Rest in Peace Om shanti!

Written by Prof Nagesh Iyer- friend and colleague

May God Bless His Soul to Rest in Peace

Prof DS Varma

(July 31, 1934 - January 27, 2021)

Prof DS Varma born on July 31, 1934 passed away on January 27, 2021.

Prof DS Varma, Formerly Director, NERIST, Itanagar and Formerly, Professor of Textile Engineering, IIT Delhi had made significant research contributions in the areas of Textile Engineering and Polymer Science including understanding the structure-property relationships in polymeric and fibrous materials. He obtained his Doctor of Science Degree from University of Glasgow, UK. His research work in the area of polymer blends and fibre reinforced composites including fabrication of hybrid composites with improved shear properties is well recognized. These studies have contributed towards the understanding of supermolecular structure of polymer blends on the ultimate fibre properties. Naturally occurring coir/jute fibres have been modified and utilized for fabrication of hybrid composites which have very low thermal conductivity and can be used for ablative purpose and as substitute for timber. His research work has significance in the field of low temperature manufacture of PAN-based carbon fibres. Prof DS Varma was recognized as a teacher, researcher and administrator.

May God Bless His Soul to Rest in Peace

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Engineering And Technology Updates

Civil Engineering

1. Role of dams in reducing global flood exposure under climate change

A new collaborative study led by researchers at the National Institute for Environmental Studies, the University of Tokyo, and Michigan State University exposes the role of dams for mitigating flood risk under climate change. Flood is amongst the costliest natural disasters. Globally, flood risk is projected to increase in the future, driven by climate change and population growth. The role of dams in flood mitigation, previously unaccounted for, was found to decrease by approximately 15% the number of people globally exposed to historical once-in-100-year floods, downstream of dams during the 21st century. Currently, about half of major river systems worldwide are regulated by dams and more than 3,700 major dams are planned or under construction. Consequently, to realistically assess population exposure to present and future floods, current and future dam landscapes must be integrated into existing flood modeling frameworks. Accounting for dams in river flood simulations, the number of people exposed to the historical once-in-100-year flood below dams were 7.2 and 13.4 million on average over 2006-2099 given a low and a medium-high greenhouse gas emission trajectory. The populations exposed to flooding below dams decreased on average by 16.3% and 12.8% for the two trajectories compared to simulations not accounting for the flow regulations produced by dams. At the end of the 21st century, the decrease was further extended to 20.6% and 12.9% respectively. To maintain the levels of flood protection that dams have provided, new dam operations will be required to offset the effect of climate change, possibly negatively affecting energy production and water storage. In addition, precise and reliable hydro-meteorological forecasts will be invaluable for enhancing flood protection and avoid excessive outflows. Given the many negative environmental and social impacts of dams, comprehensive assessments that consider both potential benefits and adverse effects are necessary for the sustainable development of water resources.

Source https://www.sciencedaily.com/releases/2021/01/210122084954.htm

2. New blueprint for more stable quantum computers

Researchers at the Paul Scherrer Institute PSI have put forward a detailed plan of how faster and better defined quantum bits -- qubits -- can be created. The central elements are magnetic atoms from the class of so-called rare-earth metals, which would be selectively implanted into the crystal lattice of a material. Each of these atoms represents one qubit. The researchers have demonstrated how these qubits can be activated, entangled, used as memory bits, and read out. On the way to quantum computers, an initial requirement is to create so-called quantum bits or "qubits": memory bits that can, unlike classical bits, take on not only the binary values of zero and one, but also any arbitrary combination of these states. "With this, an entirely new kind of computation and data processing becomes possible, which for specific applications means an enormous acceleration of computing power," explains PSI researcher Manuel Grimm, first author of a new paper on the topic of qubits. The authors describe how logical bits and basic computer operations on them can be realised in a magnetic solid: qubits would reside on individual atoms from the class of rare-earth elements, built into the crystal lattice of a host material. On the basis of quantum physics, the authors calculate that the nuclear spin of the rare-earth atoms would be suitable for use as an information carrier, that is, a qubit. They further propose that targeted laser pulses could momentarily transfer the information to the atom's electrons and thus activate the qubits, whereby their information becomes visible to surrounding atoms. Two such activated qubits communicate with each other and thus can be "entangled." Entanglement is a special property of quantum systems of multiple particles or qubits that is essential for quantum computers: The result of measuring one qubit directly depends on the measurement results of other qubits, and vice versa. The researchers demonstrate how these qubits can be used to produce logic gates, most notably the "controlled NOT gate" (CNOT gate). Logic gates are the basic building blocks that also classical computers use to perform calculations. If sufficiently many such CNOT gates as well as single-qubit gates are combined, every conceivable computational operation becomes possible. They thus form the basis for quantum computers. This paper is not the first to propose quantum-based logic gates. "Our method of activating and entangling the qubits, however, has a decisive advantage over previous comparable proposals: It is at least ten times faster," says Grimm. The advantage, though, is not only the speed with which a quantum computer based on this concept could calculate; above all, it addresses the system's susceptibility to errors. "Qubits are not very stable. If the entanglement processes are too slow, there is a greater probability that some of the qubits will lose their information in the meantime," Grimm explains. Ultimately, what the PSI researchers have discovered is a way of making this type of quantum computer not only at least ten times as fast as comparable systems, but also less error-prone by the same factor.

Source https://www.sciencedaily.com/releases/2021/01/210122140621.htm

3. **This robot doesn't need any electronics**

Engineers at the University of California San Diego have created a four-legged soft robot that doesn't need any electronics to work. The robot only needs a constant source of pressurized air for all its functions, including its controls and locomotion systems. Applications include low-cost robotics for entertainment, such as toys, and robots that can operate in environments where electronics cannot function, such as MRI machines or mine shafts. Soft robots are of particular interest because they easily adapt to their environment and operate safely near humans. Most soft robots are powered by pressurized air and are controlled by electronic circuits. But this approach requires complex components like circuit boards, valves and pumps -- often outside the robot's body. These components, which constitute the robot's brains and nervous system, are typically bulky and expensive. By contrast, the UC San Diego robot is controlled by a light-weight, low-cost system of pneumatic circuits, made up of tubes and soft valves, onboard the robot itself. The robot can walk on command or in response to signals it senses from the environment. "With our approach, you could make a very complex robotic brain," said Tolley, the study's senior author. "Our focus here was to make the simplest air-powered nervous system needed to control walking." The robot's computational power roughly mimics mammalian reflexes that are driven by a neural response from the spine rather than the brain. The team was inspired by neural circuits found in animals, called central pattern generators, made of very simple elements that can generate rhythmic patterns to control motions like walking and running.To mimic the generator's functions, engineers built a system of valves that act as oscillators, controlling the order in which pressurized air enters air-powered muscles in the robot's four limbs. Researchers built an innovative component that coordinates the robot's gait by delaying the injection of air into the robot's legs. The robot's gait was inspired by sideneck turtles.

The robot is also equipped with simple mechanical sensors -- little soft bubbles filled with fluid placed at the end of booms protruding from the robot's body. When the bubbles are depressed, the fluid flips a valve in the robot that causes it to reverse direction. The Science Robotics paper builds on previous work by other research groups that developed oscillators and sensors based on pneumatic valves, and adds the components necessary to achieve high-level functions like walking. The robot is equipped with three valves acting as inverters that cause a high pressure state to spread around the air-powered circuit, with a delay at each inverter. Each of the robot's four legs has three degrees of freedom powered by three muscles. The legs are angled downward at 45 degrees and composed of three parallel, connected pneumatic cylindrical chambers with bellows. When a chamber is pressurized, the limb bends in the opposite direction. As a result, the three chambers of each limb provide multi-axis bending required for walking. Researchers paired chambers from each leg diagonally across from one another, simplifying the control problem. A soft valve switches the direction of rotation of the limbs between counterclockwise and clockwise. That valve acts as what's known as a latching double pole, double throw switch -- a switch with two inputs and four outputs, so each input has two corresponding outputs it's connected to. That mechanism is a little like taking two nerves and swapping their connections in the brain. In the future, researchers want to improve the robot's gait so it can walk on natural terrains and uneven surfaces. This would allow the robot to navigate over a variety of obstacles. This would require a more sophisticated network of sensors and as a result a more complex pneumatic system. The team will also look at how the technology could be used to create robots, which are in part controlled by pneumatic circuits for some functions, such as walking, while traditional electronic circuits handle higher functions.

Source https://www.sciencedaily.com/releases/2021/02/210217151054.htm

4. More sustainable recycling of plastics

The new method works without extremely high temperatures, is therefore more energy-efficient and has a significantly higher recovery rate (approx. 96 per cent of the starting material) than established processes. "The direct re-utilization of plastics is often hampered by the fact that, in practice, mechanical recycling only functions to a limited degree -- because the plastics are contaminated and mixed with additives, which impairs the properties of the recycled materials,"a lead researcher explains. "Chemical recycling" is an alternative: Via a chemical process, used plastic is broken down into its molecular building blocks, which can then be converted into new plastic. Specifically in the case of polyethylene -- the most widely used plastic -- chemical recycling is difficult. On a molecular level, plastics are made up of long molecular chains. "Polymer chains of polyethylene are very stable and not easily reversed back into small molecules," researcher Stefan Mecking explains. Temperatures exceeding 600° Celsius are required, making the procedure energy-consuming. At the same time, the recovery rate is limited. Stefan Mecking and his team report on a method that makes a more energy-efficient chemical recycling of polyethylene-like plastics possible, coupled with a very high recovery rate of around 96 per cent of the starting materials. To do so, the chemists used "breaking-points" on a molecular level enabling a deconstruction of the chain into smaller molecular building blocks. "Key for our method are polymers with a low density of predetermined breaking-points in the polyethylene chain, so that the crystalline structure and material properties are not compromised," Stefan Mecking explains and adds: "This type of materials is also very suitable for 3D printing." Stefan Mecking´s research team demonstrated this chemical recycling on polyethylene-like plastics based on plant oil. The recycling stage requires temperatures of only about 120 degrees. Furthermore, the chemists also performed this recycling method on mixed plastics as they occur in waste streams. The properties of the recycled materials are on a par with those of the starting material. "Recyclability is an important aspect for future technologies based on plastics. Re-utilizing such valuable materials as efficiently as possible makes sense. With our research we want to contribute to making chemical recycling of plastics more sustainable and effective," Stefan Mecking resumes.

Source https://www.sciencedaily.com/releases/2021/02/210217114432.htm

Electrical Engineering

5. Nanowire could provide a stable, easy-to-make superconducting transistor

Superconductors provide a macroscopic glimpse into quantum phenomena, which are usually observable only at the atomic level. Beyond their physical peculiarity, superconductors are also useful. They're found in medical imaging, quantum computers, and cameras used with telescopes. But superconducting devices can be finicky. Often, they're expensive to manufacture and prone to err from environmental noise. That could change, thanks to research from Karl Berggren's group in the Department of Electrical Engineering and Computer Science. The researchers are developing a superconducting nanowire, which could enable more efficient superconducting electronics. The nanowire's potential benefits derive from its simplicity, says Berggren. "At the end of the day, it's just a wire."Most metals lose resistance and become superconducting at extremely low temperatures, usually just a few degrees above absolute zero. They're used to sense magnetic fields, especially in highly sensitive situations like monitoring brain activity. They also have applications in both quantum and classical computing. Underlying many of these superconductors is a device invented in the 1960s called the Josephson junction -- essentially two superconductors separated by a thin insulator. "That's what led to conventional superconducting electronics, and then ultimately to the superconducting quantum computer," says Berggren. However, the Josephson junction "is fundamentally quite a delicate object," Berggren adds. That translates directly into cost and complexity of manufacturing, especially for the thin insulating later. Josephson junction-based superconductors also may not play well with others: "If you try to interface it with conventional electronics, like the kinds in our phones or computers, the noise from those just swamps the Josephson junction. So, this lack of ability to control larger-scale objects is a real disadvantage when you're trying to interact with the outside world." To overcome these disadvantages, Berggren is developing a new technology -- the superconducting nanowire -- with roots older than the Josephson junction itself. In 1956, MIT electrical engineer Dudley Buck published a description of a superconducting computer switch called the cryotron. The device was little more than two superconducting wires: One was straight, and the other was coiled around it. The cryotron acts as a switch, because when current flows through the coiled wire, its magnetic field reduces the current flowing through the straight wire. At the time, the cryotron was much smaller than other types of computing switches, like vacuum tubes or transistors, and Buck thought the cryotron could become the building block of computers. But in 1959, Buck died suddenly at age 32, halting the development of the cryotron. Now, Berggren is rekindling Buck's ideas about superconducting computer switches. The nano-cryotron uses heat to trigger a switch, rather than a magnetic field. In Berggren's device, current runs through a superconducting, supercooled wire called the "channel." That channel is intersected by an even smaller wire called a "choke" -- like a multilane highway intersected by a side road. When current is sent through the choke, its superconductivity breaks down and it heats up. Once that heat spreads from the choke to the main channel, it causes the main channel to also lose its superconducting state. Berggren's group has already demonstrated proof-of-concept for the nano-cryotron's use as an electronic component. They have developed a device that uses nano-cryotrons to add binary digits. And Berggren has successfully used nano-cryotrons as an interface between superconducting devices and classical, transistor-based electronics. Berggren says his group's superconducting nanowire could one day complement -- or perhaps compete with -- Josephson junction-based superconducting devices. He thinks the nano-cryotron could one day find a home in superconducting quantum computers and supercooled electronics for telescopes.

Source https://www.sciencedaily.com/releases/2021/02/210211144324.htm

6. Artificial emotional intelligence: a safer, smarter future with 5G and emotion recognition

With the advent of 5G communication technology and its integration with AI, we are looking at the dawn of a new era in which people, machines, objects, and devices are connected like never before. This smart era will be characterized by smart facilities and services such as self-driving cars, smart UAVs, and intelligent healthcare. This will be the aftermath of a technological revolution.But the flip side of such technological revolution is that AI itself can be used to attack or threaten the security of 5G-enabled systems which, in turn, can greatly compromise their reliability. It is, therefore, imperative to investigate such potential security threats and explore countermeasures before a smart world is realized. In a recent study, a team of researchers led by Prof. Hyunbum Kim from Incheon National University, Korea, address such issues in relation to an AI-based, 5G-integrated virtual emotion recognition system called 5G-I-VEmoSYS, which detects human emotions using wireless signals and body movement. "Emotions are a critical characteristic of human beings and separates humans from machines, defining daily human activity. However, some emotions can also disrupt the normal functioning of a society and put people's lives in danger, such as those of an unstable driver. Emotion detection technology thus has great potential for recognizing any disruptive emotion and in tandem with 5G and beyond-5G communication, warning others of potential dangers," explains Prof. Kim. "For instance, in the case of the unstable driver, the AI enabled driver system of the car can inform the nearest network towers, from where nearby pedestrians can be informed via their personal smart devices." The virtual emotion system developed by Prof. Kim's team, 5G-I-VEmoSYS, can recognize at least five kinds of emotion (joy, pleasure, a neutral state, sadness, and anger) and is composed of three subsystems dealing with the detection, flow, and mapping of human emotions. The system concerned with detection is called Artificial Intelligence-Virtual Emotion Barrier, or AI-VEmoBAR, which relies on the reflection of wireless signals from a human subject to detect emotions. This emotion information is then handled by the system concerned with flow, called Artificial Intelligence-Virtual Emotion Flow, or AI-VEmoFLOW, which enables the flow of specific emotion information at a specific time to a specific area. Finally, the Artificial Intelligence-Virtual Emotion Map, or AI-VEmoMAP, utilizes a large amount of this virtual emotion data to create a virtual emotion map that can be utilized for threat detection and crime prevention. A notable advantage of 5G-I-VEmoSYS is that it allows emotion detection without revealing the face, thereby protecting the privacy of citizens in public areas. Furthermore, when a serious emotion, such as anger or fear, is detected in a public area, the information is rapidly conveyed to the nearest police department or relevant entities who can then take steps to prevent any potential crime or terrorism threats. However, the system suffers from serious security issues such as the possibility of illegal signal tampering, abuse of anonymity, and hacking-related cyber-security threats. Further, the danger of sending false alarms to authorities remains. While these concerns do put the system's reliability at stake, Prof. Kim's team are confident that they can be countered with further research. "This is only an initial study. In the future, we need to achieve rigorous information integrity and accordingly devise robust AI-based algorithms that can detect compromised or malfunctioning devices and offer protection against potential system hacks," explains Prof. Kim, "Only then will it enable people to have safer and more convenient lives in the advanced smart cities of the future."

Source https://www.sciencedaily.com/releases/2021/02/210211113917.htm

7. Orbex Commissions Largest Industrial 3D Printer in Europe for Rapid Rocket-Building

Orbex has commissioned AMCM to build the largest industrial 3D printer in Europe, allowing the innovative UK-based space launch company to rapidly print complex rocket engines in-house. The custom-made, large volume 3D printer will allow Orbex to print more than 35 large-scale rocket engine and main stage turbopump systems annually, as the company scales up its production capabilities for launches. The multi-million pound deal was signed with AMCM, following a series of successful trials printing various large-scale rocket components over a number of months. AMCM will deliver a complete printing suite with post-processing machinery and 'Machine Vision' systems, providing automatic imaging-based inspection of printed components. To accommodate the new machinery, Orbex is expanding its factory floor space by an additional 1,000 m^2. The 3D printing system will print rocket parts using a custom blend of metals including titanium and aluminium to create a lightweight system designed to withstand the temperature and pressure extremes of spaceflight. Orbex will print components such as rocket engines as a single piece, eliminating the weaknesses which can arise from joining and welding. The 3D printed rocket components will be critical parts of Orbex's launch vehicle, a 19-metre long "microlauncher" rocket, designed to deliver small satellites into polar orbits around the Earth. Planning permission was granted for Orbex's home spaceport, Space Hub Sutherland, at the A'Mhoine peninsula in Sutherland in August 2020. The A'Mhoine site is currently the only UK spaceport to receive planning permission, with construction expected to begin in 2021 and the first orbital launch expected in 2022. Uniquely for a commercial rocket, Prime is fueled by bio-propane, a clean-burning, renewable fuel which reduces CO2 emissions by 90% compared to kerosene-based fuels. The Prime rocket was designed to be re-usable, incorporating a novel recovery and reusability system. The rocket has also been designed to leave zero debris in orbit around the Earth. "Although our rocket engines and other critical systems are already quite mature after years of testing, a large-scale in-house 3D printing system like this gives us far greater speed and agility as we ramp up production," said Chris Larmour, CEO of Orbex. "It means we can continue to iterate and drive up performance even further. Longer term, as we get ready for multiple launches per year, it will give us greater control over our costs and supply chain. After exhaustive trials, the results we've seen from AMCM were very successful and we're confident that we've made the right choice of partner." "Investing in a large-scale 3D printing system like this says a lot about Orbex's ambition in the European spaceflight sector," said Martin Bullemer, MD of AMCM. "If they are to lead the European market, they need the production reliability and speed that a large-scale 3D printing system like this will give them. And although this is a major purchase, it will allow for significant cost control for Orbex in the years to come."

Source http://spaceref.com/news/viewpr.html?pid=57046

Mining, Metallurgical and Materials Engineering

8. Engineers develop programming technology to transform 2D materials into 3D shapes

University of Texas at Arlington researchers have developed a technique that programs 2D materials to transform into complex 3D shapes. The goal of the work is to create synthetic materials that can mimic how living organisms expand and contract soft tissues and thus achieve complex 3D movements and functions. Programming thin sheets, or 2D materials, to morph into 3D shapes can enable new technologies for soft robotics, deployable systems, and biomimetic manufacturing, which produces synthetic products that mimic biological processes. Kyungsuk Yum, an associate professor in the Materials Science and Engineering Department, and his team have developed the 2D material programming technique for 3D shaping. It allows the team to print 2D materials encoded with spatially controlled in-plane growth or contraction that can transform to programmed 3D structures. "There are a variety of 3D-shaped 2D materials in biological systems, and they play diverse functions," Yum said. "Biological organisms often achieve complex 3D morphologies and motions of soft slender tissues by spatially controlling their expansion and contraction. Such biological processes have inspired us to develop a method that programs 2D materials with spatially controlled in-plane growth to produce 3D shapes and motions." With this inspiration, the researchers developed an approach that can uniquely create 3D structures with doubly curved morphologies and motions, commonly seen in living organisms but difficult to replicate with human-made materials. They were able to form 3D structures shaped like automobiles, stingrays, and human faces. To physically realize the concept of 2D material programming, they used a digital light 4D printing method developed by Yum and shared in Nature Communications in 2018. "The researchers also introduced the concept of cone flattening, where they program 2D materials using a cone surface to increase the accessible space of 3D shapes. To solve a shape selection problem, they devised shape-guiding modules in 2D material programming that steer the direction of shape morphing toward targeted 3D shapes. Their flexible 2D-printing process can also enable multimaterial 3D structures.

Source https://www.sciencedaily.com/releases/2021/02/210205085730.htm

Energy Engineering

9. From waste heat to electrical power: A new generation of thermomagnetic generators

Use of waste heat contributes largely to sustainable energy supply. Scientists of Karlsruhe Institute of Technology (KIT) and Tōhoku University in Japan have now come much closer to their goal of converting waste heat into electrical power at small temperature differences. As reported in Joule, electrical power per footprint of thermomagnetic generators based on Heusler alloy films has been increased by a factor of 3.4. Many technical processes only use part of the energy consumed. The remaining fraction leaves the system in the form of waste heat. Frequently, this heat is released into the environment unused. However, it can also be used for heat supply or power generation. The higher the temperature of the waste heat is, the easier and cheaper is its reuse. Thermoelectric generators can use waste heat of low temperature for direct conversion into electrical power. Thermoelectric materials used so far, however, have been expensive and sometimes even toxic. Moreover, thermoelectric generators require large temperature differences for reaching efficiencies of just a few percent. Thermomagnetic generators represent a promising alternative. They are based on alloys, whose magnetic properties are highly temperature-dependent. Alternating magnetization induces an electrical voltage in a coil applied. Researchers presented first concepts of thermomagnetic generators in the 19th century already. Since then, research has covered a variety of materials. Electrical power, however, has left a lot to be desired. Scientists of KIT's Institute of Microstructure Technology (IMT) and Tōhoku University in Japan have now succeeded in largely increasing the electrical power per footprint of thermomagnetic generators. So-called Heusler alloys -- magnetic intermetallic compounds -- are applied in the form of thin films in thermomagnetic generators and provide for a big temperature-dependent change of magnetization and quick heat transfer. This is the basis of the new concept of resonant self-actuation. Even at small temperature differences, resonant vibrations are induced in devices and can be converted efficiently into electrical power. Still, electrical power of single devices is low and upscaling will depend on material development and engineering. The researchers of KIT and Tōhoku University used a nickel-manganese-gallium alloy and found that alloy film thickness and the device footprint influence electrical power in opposite directions. Based on this finding, they succeeded in improving electrical power per footprint by a factor of 3.4 by increasing the thickness of the alloy film from five to 40 micrometers. The thermomagnetic generators reached a maximum electrical power of 50 microwatts per square centimeter at a temperature change of just three degrees Celsius. "These results pave the way to the development of customized thermomagnetic generators connected in parallel for potential use of waste heat close to room temperature," Kohl explains.

Source https://www.sciencedaily.com/releases/2021/02/210203123402.htm

10. Hydrogel promotes wound healing better than traditional bandages, gauzes

The widespread use of high-speed and high-energy weapons in modern warfare has led to an increasing incidence of explosive injuries. For such wounds as well as those incurred in disasters and accidents, severe haemorrhage is the leading cause of death. Researchers from the Southern University of Science and Technology in China examined the advances in hydrogel dressings in recent years, which are good at promoting wound healing and can better meet the demands of different situations. While bandages and gauzes are effective in controlling hemorrhage, they have various limitations. They are not biodegradable and are susceptible to infection and unsuitable for irregularly shaped wounds. They might also cause secondary tissue damage and are almost ineffective for wound healing. Many hydrogel wound dressings are antibacterial, biodegradable, responsive, and injectable. Conventional dressings, in contrast, have a single function, making them less effective for wound treatment. Hydrogel is a 3D network that is composed of hydrophilic polymers, which can absorb and swell in water. Hydrogels can be prepared by different cross-linking strategies, and they are classified in different ways based on their constitutes. Polysaccharide-based hydrogels are biocompatible, biodegradable, and nontoxic. In contrast, synthetic polymer-based hydrogels are more easily modified and have better mechanical strength. When used as a wound dressing, hydrogel not only forms a physical barrier and removes excess exudate but also provides a moisture environment that promotes the wound healing process. Additionally, hydrogel can perfectly fill irregularly shaped wounds and deal with deep bleeding efficiently. The poor mechanical strength of existing hydrogel dressings limits their applications in the treatment of massive bleeding, such as arterial ruptures, since they cannot provide effective protection for the wound to prevent secondary damage. Consequently, the researchers will focus future research on developing hydrogel dressings with high mechanical strength so these dressings could help with fatal severe haemorrhage. "Hydrogels are a kind of superior material," said Wu. "In my opinion, high-performance hydrogels also have potential in the field of tissue engineering to replace some tissues that can self-heal and regenerate, such as annulus fibrosus, meniscus, and cornea."

Source https://www.sciencedaily.com/releases/2021/02/210216114953.htm

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Engineering Innovation in India

Mumbai-based BARC designs first research reactor through PPP model

The Bhabha Atomic Research Centre (BARC) has designed a research reactor that can make radioisotopes available at low costs to medical and other industries. In a first, the premiere nuclear research organisation of the department of atomic energy (DAE) will share the technology with industries through a public-private partnership. This is expected to bring down costs of cancer treatment in India. Radioisotopes are radioactive isotopes that have an unstable atomic nucleus. They emit energy and particles when they change to a more stable form. Radioisotopes are widely used in nuclear medicine for diagnostics as well as to treat diseases such as cancer. The industrial uses of radioisotopes include identifications of flow malfunctions, measurement of flow parameters, evaluation of design of chemical reactors, monitoring of product quality and process efficacy. In India, all major radioisotopes are produced by the BARC, which houses research reactors in its Trombay campus and an accelerator in Kolkata. Some radioisotopes are imported from Europe, Australia and other Asian countries. Radioisotopes in India can be procured and handled only by the users duly authorised by the radiological safety division (RSD), Atomic Energy Regulatory Board (AERB). Private entities that are willing to invest in the construction of the research reactor and its processing units will get exclusive rights to process and market the radioisotopes produced in the reactor. Meanwhile, the demand for radioisotopes for nuclear medicine is on the rise. Between 2018 and 2020, the number of nuclear medicine departments in the country's hospitals has grown from 293 to 349, according to AERB. "Typically, research reactors have facilities such as radioisotope production, testing of structural materials for its use in nuclear reactors, making neutrons available for material science studies etc. The research reactor planned by BARC primarily has facilities for radioisotope production. Apart from medical radioisotopes, provisions are also made for producing radioisotopes for industrial use like Cobalt-60, Iridium-192, Bromine-82 etc," said an email response from the office of Shri KN Vyas, secretary, DAE. The proposed research reactor is expected to bring down the cost of nuclear medicine, which are extensively used for cancer treatment. "As the research reactor (under planning stage) is expected to produce a relatively large quantity of radioisotopes and the associated facilities are also catering to relatively large quantities of radiopharmaceuticals, it is felt that the cost of producing radiopharmaceuticals may reduce. As the radiopharmaceuticals are being manufactured indigenously, it is expected that increased self-sufficiency will lead to cheaper radiopharmaceuticals and consequently reduce the cost of cancer treatment," read the response from Shri Vyas. DAE has said that it is in discussion with potential Indian and global investors and the identification of a suitable site for the reactor is in process. The research reactor is expected to come online in five years after the construction begins, said DAE.

Source https://www.hindustantimes.com/cities/others/mumbaibased-barc-designs-first-research-reactor-through-ppp-model-101613326906279.html#:~:text=Mumbai%2Dbased%20BARC%20designs%20first%20research%20reactor%20through%20PPP%20model,-The%20Bhabha%20Atomic&text=In%20a%20first%2C%20the%20premiere,of%20cancer%20treatment%20in%20India

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