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 being opened.** 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 being opened.** Last date of receipt of nominations: **March 31, 2021.** For details click on the link given below.

  Link for Young Engineer Award

- **Nominations invited for Mentoring of Engineering Teachers and Students by INAE Fellows.** For details visit INAE website at the links Mentoring-Teacher and Mentoring-Student Last date for the receipt of nominations**: February 7, 2021.**

INAE Annual Convention 2020 Webinar Series Programme held from January 4 -20, 2021

As part of the online INAE Annual Convention 2020, INAE conducted a special Webinar Series from January 4, 2021 to January 20, 2021 featuring technical lectures by awardees for the year 2020 of Life Time Contribution Award in Engineering, Prof Jai Krishna & Prof SN Mitra Memorial Awards, INAE Outstanding Teachers Award, INAE Woman Engineer of the Year Award, Young Entrepreneur Award, Innovative Student Projects Award at Doctoral Level, Young Engineer Award and Newly elected Fellows/ Foreign Fellows affiliated to ten Engineering Sections of INAE. The Programme of INAE Webinar Series that has been organized between January 4-20, 2021 featuring presentations by distinguished awardees/Newly Elected Fellows/Foreign Fellows can be viewed by clicking here….

The presentations focused upon the technical contributions of newly elected Fellows and awardees which were followed by interactive Question and Answer session and summing up of presentations and concluding remarks by the Chairpersons. The Chairpersons comprised of President, INAE and former Presidents and Conveners of the ten Sectional Committees. There was active participation in the webinars and lectures were high in technical content and were found to be interesting for the Audience. There was a total of 77 presentations and about 600 participants in all.

The presentations made on January 4, 2021 comprised of lectures by Prof. KA Padmanabhan and Dr TSR Prasada Rao- the Lifetime Contribution in Engineering Awardees, followed by Dr V Ramaswamy and Prof LM Patnaik -the Prof Jai Krishna and Prof SN Mitra Memorial awardees. The session on Day 1 was Chaired by Dr PS Goel, former President, INAE. Day 2 featured the presentations by Prof Ranjit Kumar Ray and Prof Bhim Singh - the Outstanding Teacher Awardees and Prof. Sanghamitra Bandyopadhyay, Dr VR Lalithambika and Dr Dheepa Srinivasan – the Woman Engineer of the year awardees and the session was Chaired by Dr BN Suresh, Past-President, INAE. Day 3 featured Session on Lectures by Newly Elected Fellows under Rule 37(g) and Lectures by INAE Young Entrepreneur Award Winners and the session was chaired by Dr. Sanak Mishra, President, INAE (2019-2020).

Day 4 and 5 featured Session on Lectures by Newly elected Fellows/Foreign Fellows and Young Engineer Awardees affiliated to Engg Section-I (Civil Engineering) and Engineering Section -II

(Computer Engineering and Information Technology. Day 6 entailed Award Lectures by Award Winners of INAE Young Entrepreneur Award and Innovative Student Projects Award at Doctoral Level and was chaired by Prof. Indranil Manna, President, INAE. Days 7 to 14 had interesting presentations by Newly elected Fellows/Foreign Fellows and Young Engineer Awardees affiliated to Engineering Section – III (Mechanical Engineering); Engineering section -IV (Chemical Engineering); Engineering Section -V (Electrical Engineering); Engineering Section -VI (Electronics and Communication Engineering); Engineering Section -VII (Aerospace Engineering); Engineering Section -VIII (Mining, Metallurgical and Materials Engineering); Engineering Section- IX (Energy Engineering) and Engineering Section -X (Interdisciplinary and Special Engineering Fields and Leadership in Academia, R&D and Industry) respectively. The Sectional Committee Conveners were chosen as Chairpersons for the sessions on the respective Sectional Committees. The presentations will be uploaded on the INAE Website shortly for the benefit of researchers and readers.

The Annual Convention Webinar Series presented an exciting opportunity for the awardees and newly elected Fellows to interact with the Fellows and invitees on pertinent technical issues. The webinar series was unique in its outlay and was an outstanding success and appreciated by all delegates.

INAE Webinar Series

Webinar 10: High Intensity Superconducting Proton Accelerators (HISPA): Challenges & Achievements.

Webinar 10 of the INAE Webinar Series was organized by INAE Mumbai Chapter on December 17, 2020 featuring talk on "High Intensity Superconducting Proton Accelerators (HISPA): Challenges & Achievements" by Dr. Srinivas Krishnagopal, Head Ion, Accelerator Development Division, Bhabha Atomic Research Centre. Link for recording of webinar:
https://www.youtube.com/watch?v=WBNtEDnOKBs

INAE Bangalore Chapter organized a Webinar talk by Dr. Ravishankar Krishnaswamy, Principal Researcher, Microsoft Research India on "Recent Algorithms and Systems for Nearest Neighbor Search" on December 24, 2020. 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, Defense Research and Development Laboratory on "Thermo-Structural Testing of One-to-One Aerospace Structures using Infrared Heating "on November 26, 2020. Link for recording of webinar:
https://www.youtube.com/watch?v=v_1zUMFDeL8

Webinar 11: "**Engineering of Carbon Nanotubes and their Applications**" on **27th January 2021**

Webinar 11 on "Engineering of Carbon Nanotubes and their Applications" was organized on 27th January 2021 over WebEx which was coordinated by INAE Mumbai Chapter. The Session was moderated by Dr R B Grover, FNAE, Co-Convener, INAE Mumbai Chapter, Emeritus Professor, Homi Bhabha National Institute, Mumbai and the speaker for the session was Dr Kinshuk Dasgupta, Bhabha Atomic Research Centre, Recipient of Shanti Swarup Bhatnagar Award 2020 in Engineering Science.

In his talk Dr. Dasgupta spoke about the large-scale synthesis of carbon nanotubes (CNTs) by fluidized bed chemical vapour deposition (FB-CVD) and floating catalyst chemical vapour deposition (FC-CVD) techniques. He discussed about the fluidization of nano-particles and different steps involving mass transfer and chemical reactions during the synthesis of CNTs. He explained the influence of different process parameters on the growth rate of CNTs leading to developing a mathematical model for the overall rate of reaction and identifying the rate controlling steps. Further, Dr. Dasgupta talked about the use of CNTs for various applications. He discussed the CNT-polymer composite beads for rare-earth extraction, functionalized carbon nanotubes for actinide separation and metal-filled carbon nanotubes

as nano-magnets. Improvement of mechanical properties of ceramic and polymer matrix composites with the addition of CNTs was also showcased by Dr. Dasgupta in his presentation. These improved composites were utilized in developing Bhabha Kavach, a light-weight import-substitute bullet proof jacket for Indian Armed Forces. Dr. Dasgupta informed that the technology of Bhabha Kavach has been transferred to the industries for large-scale production. After the panel discussion, the webinar was concluded with the vote of thanks by Dr. (Mrs.) S. B. Roy.

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. G. Janakiram, General Manager (Technical Services), Eurotex Industries & Exports Ltd, Kolhapur	DKTE Society's Textile & Engineering Institute, Ichalkaranji Dec 14-16, 2020	Delivered lectures on "Optimization of Pre-spinning Process Parameters", "Suitability of Process Parameters for Post-spinning", Maintenance Approach to Pre-spinning Machines", "Maintenance Approach to Post-spinning Machines". According to the feedback received from the Institute, students of the textile department got benefitted by the lecture of DVP. Some of the UG candidates got directions for research work and the interactions also helped to finalize their project plan on their topic.
Prof. S. K. Gupta Former Project Coordinator (Saline Water), CSSRI .	Karnal Institute of Technology and Management, Karnal Dec 22-24, 2020	Delivered lectures on "Rainfall: Frequency Analysis and Areal Distribution", "Estimating Runoff from Rainfall: Theoretical and Field Methods" and "Water Quality Guidelines"" According to the feedback received from the Institute, the institute is taking full advantage of the DVP Expertise for on-line classes. The institute is exploring other opportunities to take additional advantage of the presence of DVP online. The institute believe that the DVP visits will motivate the students to excel in various activities.
Prof. Ganapati Panda, FNAE	Raghu Institute of Technology, Vishakhapatnam	Delivered lectures on "Introduction to several Variants of Neural Networks and their Applications", "Project Based Learning", "Machine Learning Techniques",

Former Deputy Director & Prof. School of Electrical Sciences, IIT Bhubaneswar, Research Advisor for CV Raman College of Engineering, Bhubaneswar, Odisha	Dec 28-30, 2020	"Deep Learning Basics", "Applications of Deep Learning", "Convolutional Neural Networks", "Recurrent NN", "Feature Extraction for classification and Clustering Applications", "Biological Neural Networks - Spiking Neuron", "Deep Learning with Spiking Neuron", "Auto Encoder variational AE, Denoising AE, Sparse AE, Hopfield network", "Generative Adversarial Networks" and "How to Write a Research Paper". As per the feedback received from the Institute, the Distinguished Visiting Professorship Scheme has helped interaction with Prof. G. Panda to facilitate research and curriculum formulation. Teaching faculty and PhD scholars in the Department were benefited by his lectures directly. His interactions were of immense help in motivating to enhance the R&D activities of the college. Most of the suggested projects are industry related and the students carry out those with the help of techniques taught by Prof. G. Panda.

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

International Conference on Emerging Trends in Electronics and Telecommunications being held on 19th to 20th February 2021 at Pune
https://conferencealerts.com/show-event?id=230918

International Conference on Innovative Computing & Communication being held on 20th to 21st February 2021 at New Delhi,
https://conferencealerts.com/show-event?id=231429

4th International Conference on Intelligent Sustainable Systems (ICISS 2021) being held on 26th to 27th February 2021at Tirunelveli, Tamil Nadu,
https://conferencealerts.com/show-event?id=228909

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

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Honours and Awards

1.	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 is the winner of the Subhash Chandra Bose Aapda Prabandhan Puraskar 2021 Award in the field of Disaster Management. Government of India instituted the annual award known as Subhash Chandra Bose Aapda Prabandhan Puraskar to recognize and honour the invaluable contribution and selfless service rendered by individuals and organizations in India in the field of Disaster Management. The award is announced every year on 23rd January, the birth anniversary of Netaji Subhash Chandra Bose. For the year 2021, (i) Sustainable Environment and Ecological Development Society (in the institutional category) and (ii) Dr. Rajendra Kumar Bhandari (in the Individual category) have been selected for the Subhash Chandra Bose Aapda Prabandhan Puraskar for their excellent work in Disaster Management. Further details can be viewed at the link given below. https://pib.gov.in/PressReleasePage.aspx?PRID=1691607

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News of Fellows

1.	Mr VK Agarwal, FNAE, Formerly Chairman, Railway Board & Ex-officio Principal Secretary, Govt. of India after studying a wide spectrum of subjects ranging from highly scientific / technical areas to social, economic, financial, philosophical, meta-physical and religious areas has prepared a list/ dictionary of Words, Terms & Abbreviations through a process of systematic compilation which runs into 587 Pages / 7844 Items. The same can be viewed by clicking on the link given below. https://www.dropbox.com/sh/cia9t67ivj2fltw/AACEBaQlkHX9J0NShEmrY4dOa?dl=0
2.	Dr BVA Rao, FNAE, Professor (Retd), IIT Madras; Former Pro-Chancellor, VITU Vellore and Adjunct Professor, NIAS, Bangalore has published four Volumes of his lectures/talks at various Forums and Seminars relating to "Higher Education in Engineering and Technology - Current and Futuristic Strategies" collated over a period of time. Each of these volumes related to some specific aspects needed for improving our system to meet global challenges in Higher Education.

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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

Prof. D.K. Paul
(1947-2020)

Professor D.K. Paul (DKP), born on 28 May 1947, passed away in the afternoon of December 27, 2020. With his untimely departure, India has lost an outstanding earthquake engineer, his scores of students across the country and abroad have lost an adorable teacher and his colleagues, friends and admirers have lost an exceptional human being, full of humility and grace. His absence will be felt as long as the memories last.

DKP obtained his BSc from the Lucknow University in 1965; Bachelor's degree in Civil Engineering in 1969, Master's degree in Earthquake Engineering in 1971, from the University of Roorkee (now, Indian Institute of Technology, Roorkee); and Ph.D. Degree from University College of Swansea, the UK, in 1982. His academic track record was so remarkable that the University of Roorkee recognized him not only by award of a Gold Medal in 1971 but also appointed him as a Lecturer in the Department of Earthquake Engineering, in 1972. Since then, the University of Roorkee became his *Karma-Bhumi* where he served for about four decades. In 1978, upon receiving a Commonwealth Fellowship for doctoral studies, providence connected him with legendary Professor Zienkiewicz, a pioneer of the Finite Element Method at the University College of Swansea. Later, the same University invited him as a Visiting Professor. In 1997, the Indian National Science Academy, awarded him INSA Fellowship which DKP very effectively utilized to build taller on the work done under Zienkiewicz, especially in the areas of Finite Element Method, Nonlinear structural and Soil Dynamics involving nonlinear fluid-structure interaction and Pore fluid interaction.

IIT Roorkee made an all-round progress in the field of Earthquake Disaster Mitigation during DKP's two terms as Head of the Department of Earthquake Engineering. He later established the Centre of Excellence in Disaster Mitigation and Management at IIT Roorkee, and was instrumental in laying the foundation of multi-disciplinary programs in disaster mitigation centric research, development and extension activities. During his stint at IIT, he also served as Dean of Faculty Affairs, Deputy Director; and upon retirement as an Emeritus Fellow.

We see indelible foot prints of DKP in several areas of his impactful contributions. Throughout his professional journey, he never lost sight of the importance of National Capacity building programs. Hundreds of professionals across the country, including field engineers, architects, planners and researchers benefitted from his well-designed short term technical courses. He also contributed significantly to uplifting the level of Earthquake Engineering courses run by the Ministry of Human Resource Development and Earthquake Risk Management programs run by the Ministry of Home Affairs. Many of India's flagship development projects carry signatures of his contributions in Seismic Risk Evaluation; Seismic Retrofitting, Geotechnical Earthquake Engineering, Earthquake Resistant Design of Dams, Bridges, and Equipment and the related fields.

Another most significant dimension of national capacity building initiatives is reflected in his resolve to provide down to earth connection between best in science and technology and the felt societal needs. Throughout, it was his endeavour to make the masses aware of the basic knowledge on Earthquake Disaster Mitigation through popular lectures, well-crafted guidelines, attractive booklets, and TV films. When the devastating Uttarkashi earthquake struck on October 20, 1991, DKP lost no time to pro-actively support the national disaster mitigation initiative of the government so much so that he and his team carried out a massive awareness program covering almost all the villages in Uttaranchal with a focus on promotion of Earthquake Resistant Design and Construction practices. Inter alia, the team distributed booklets on Earthquake safe construction, spread awareness about Do's and Don'ts and, for Door Darshan, made a TV film on "Earthquakes-Surviving Nature's Fury" under the aegis of TIFAC

(DST). Under the program, he also made notable contribution to the Manual on "Technologies for Retrofitting of Existing Buildings and Structures for Earthquake Resilience ".

Yet another area of his professional expertise was design of earthquake safe construction of all kinds of structures, especially, buildings and dams. The scope covered gravity dams, earth and rock fill dams, nuclear power plants and buildings. He served on the Standing Committee for assessment of the seismic safety of Tehri rock fill dam, set up by the Prime Minister of India for the Tehri Hydro-power Development Corporation. DKP took recourse to 2D nonlinear and 3D finite element seismic safety analyses which helped the Central Government in according approval for the construction of the dam. He served as a member of Standing Advisory Committee on Seismological Network in Tehri Region; the River Valley Projects committee of the Central Water Commission, New Delhi; Project Review Committee, BRNS Projects, BARC, Bombay; and Dam Safety Review Panel of the Government of Gujarat, under a World Bank project. The scope of his engineering intervention included review & evaluation of design and reconstruction, rehabilitation & strengthening of earthquake damaged dams. He was also closely associated with the Seismic Safety Analysis of Narora, Karapar and 500 MW Atomic Power Plants and addressed the threats arising from the anticipated future strong motion earthquakes; and seismic evaluation and retrofitting design of some of the iconic buildings such as AIIMS and TRANSCO. His participation in the Delhi Earthquake Safety Initiative involving Lifeline Buildings was supported by the United States Agency for International Development (USAID). Geohazard International (GHI) solicited his expertise in implementation of the pilot project of GTB hospital building.

The lasting impact of DKP's work will continue to be felt in the area of standardization of Earthquake Resistant Design. In the words of Sanjay Pant, Head of the Civil Engineering of the Bureau of Indian Standards, "Professor Paul served as the Chairman of the Earthquake Engineering Sectional Committee, CED 39 of the Bureau of Indian Standards since 06 September 2010 till 13 November 2019 when he voluntarily relinquished the coveted position. Prior to that, he was a member of CED 39, and continued to be associated as a member till his demise. He made tremendous contributions in the preparation of standards on criteria for earthquake resistant design of various structures as well as on seismic evaluation and strengthening of existing buildings. Under his leadership, as Chairman of the Committee, various Parts of IS 1893 as well as revision of IS 13920 were published. These standards served the profession and construction industry very well, and are copiously being referred and used in the field to design and execution".

His successor on the BIS Committee, Professor CVR Murty, himself a noted expert of international repute in Earthquake Engineering, recalls: "Personally, he (DKP) tutored me for over 6 years on the matters related to the Earthquake Engineering Sectional Committee (CED39) of the BIS, to which he nominated me to succeed him as its Chairman, even when he was asked to continue." CVR further describes him as "a silent leader- whom he never saw losing his temper... Never! He was a rare human being, who met every person with grace and affection."

One of the students of DKP, Dr Shailesh Agarwal, Executive Director of Building Materials Promotion Council, remembers him "as a guide, mentor, colleague and friend". He recalled with great admiration his travels to every nook and corner of India with DKP as resource faculty to spread awareness and educate people about the lessons in disaster mitigation and management. His contribution towards development of BMTPC's Vulnerability Atlas of India and its revision was significant. DKP also guided BMTPC in the conduct of national courses on earthquake resistant design and construction and the Bihar State Disaster Management Authority (BSDMA) in building capacities of state engineers.

Over the period of four decades of his professional career, DKP served on many national level Expert Committees, Task Forces, and post disaster investigation Teams. Inter alia, he Chaired the Committees

on Micro zonation of Delhi & Guwahati cities set up by DST; and served as a member of the National Core Group for Earthquake Mitigation constituted by Ministry of Home Affairs of the Government of India. He was the Convener of the Committee that prepared disaster mitigation sensitive "Model Building Byelaws, Building Regulations, Town and Country Planning Legislation, Land Use Zoning and Development Control Regulations". He also served as a member of the Steering Committee constituted by the National Disaster Management Authority (NDMA) and as an Expert Member of Environmental Appraisal Committee, constituted by Ministry of Environment and Forest of the Government of India.

DKP was a Life Fellow of many professional bodies which include Indian Association for Computational Mechanics ;National Group for Computational Methods in Geomechanics ;Indian Society for Wind Engineering ;Indian Society for Rock Mechanics and Tunnelling ;Indian Society for Continuing Engineering Education; Indian Geotechnical Society ;Indian Institution of Bridge Engineers ;Indian Association of Structural Engineering, Indian Association of Structural Engineers; Indian Society of Earthquake Technology; and Institution of Engineers (India). In 2009, he was elected as a Fellow of Indian National Academy of Engineering.

Awards received by him include A.S. Arya — IIT Roorkee Disaster Prevention Award for the year 2007; Khosla Annual Award; and Indian Service of Engineers Annual Award, among others. He served as the President of ISET (2007-2009 & 2009-2011) after completing his terms as the Vice President (1995-1997 & 1997-1999). By 2008, he had already supervised 19 Doctoral and 51 Master theses; published 185 technical papers and completed more than 100 sponsored research & consultancy projects.

Down the memory lane, my personal and professional recollections of DKP dates back to 1976 while working at the Central Building Research Organization in Roorkee. I have had countless opportunities of working very intimately with DKP, especially, since October 2006 when, at my request, he contributed a lead paper on Numerical Modelling of Earthquake-triggered Landslides in Jointed Rock slopes, written expressly for the First India Disaster Management Congress. Subsequently, when President, INAE asked me to establish a Forum on Engineering Interventions in Disaster Mitigation, DKP was part of the first informal brainstorming which took place on 12 February 2013. Thereafter, the period between 2013 and 2018 was that of positioning the INAE Forum vis a vis national priorities and developing Actionable Recommendations on Landslide Disaster Mitigation and Management through a series of nationwide interactive dialogues. His contributions to the two INAE Roundtable meetings of the Forum held in May and November 2015 were most significant. When the much awaited report on the Mandi Earthquake Scenario came up for discussion in November 2014, his response was insightful.

Each of us is here for a brief sojourn before we go the way of all those in flesh do, but a few people leave behind unforgettable memories besides making a difference to the lives of the people they serve. DKP was one of them. In the words of his senior colleague Professor S.K. Thakkar, “we have lost an eminent structural engineer whose void is difficult to fill.”

When the history of contributions by outstanding Indian engineers is written, DKP will doubtless occupy a respectful space.

R.K. Bhandari
Chairman, INAE Forum on Engineering Interventions in Disaster Mitigation.

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Engineering And Technology Updates

Civil Engineering

1. Bio-inspired: How lobsters can help make stronger 3D printed concrete

New research shows that patterns inspired by lobster shells can make 3D printed concrete stronger, to support more complex and creative architectural structures. Digital manufacturing technologies like 3D concrete printing (3DCP) have immense potential to save time, effort and material in construction. They also promise to push the boundaries of architectural innovation, yet technical challenges remain in making 3D printed concrete strong enough for use in more free-form structures. In a new experimental study, researchers at RMIT University looked to the natural strength of lobster shells to design special 3D printing patterns. Their bio-mimicking spiral patterns improved the overall durability of the 3D printed concrete, as well as enabling the strength to be precisely directed for structural support where needed. When the team combined the twisting patterns with a specialised concrete mix enhanced with steel fibres, the resulting material was stronger than traditionally-made concrete. Lead researcher Dr Jonathan Tran said 3D printing and additive manufacturing opened up opportunities in construction for boosting both efficiency and creativity. "3D concrete printing technology has real potential to revolutionise the construction industry, and our aim is to bring that transformation closer," said Tran, a senior lecturer in structured materials and design at RMIT. "Our study explores how different printing patterns affect the structural integrity of 3D printed concrete, and for the first time reveals the benefits of a bio-inspired approach in 3DCP. "We know that natural materials like lobster exoskeletons?have evolved into high-performance structures over millions of years, so by mimicking their key advantages we can follow where nature has already innovated." The automation of concrete construction is set to transform how we build, with construction the next frontier in the automation and data-driven revolution known as industry 4.0. A 3D concrete printer builds houses or makes structural components by depositing the material layer-by-layer, unlike the traditional approach of casting concrete in a mould. The research team in RMIT's School of Engineering focuses on 3D printing concrete, exploring ways to enhance the finished product through different combinations of printing pattern design, material choices, modelling, design optimisation and reinforcement options. The most conventional pattern used in 3D printing is unidirectional, where layers are laid down on top of each other in parallel lines. The new study investigated the effect of different printing patterns on the strength of steel fibre-enhanced concrete. Previous research by the RMIT team found that including 1-2% steel fibres in the concrete mix reduces defects and porosity, increasing strength. The fibres also help the concrete harden early without deformation, enabling higher structures to be built. The team tested the impact of printing the concrete in helicoidal patterns (inspired by the internal structure of lobster shells), cross-ply and quasi-isotropic patterns (similar to those used for laminated composite structures and layer-by-layer deposited composites) and standard unidirectional patterns. The results showed strength improvement from each of the patterns, compared with unidirectional printing, but Tran said the spiral patterns hold the most promise for supporting complex 3D printed concrete structures. "As lobster shells are naturally strong and naturally curved, we know this could help us deliver stronger concrete shapes like arches and flowing or twisted structures," he said. "This work is in early stages so we need further research to test how the concrete performs on a wider range of parameters, but our initial experimental results show we are on the right track." Further studies will be supported through a new large-scale mobile concrete 3D printer recently acquired by RMIT -- making it the first research institution in the southern hemisphere to commission a machine of this kind. The 5×5m robotic printer will be used by the team to research the 3D printing of houses, buildings and large structural components.

The team will also use the machine to explore the potential for 3D printing with concrete made with recycled waste materials such as soft plastic aggregate.

Source https://www.sciencedaily.com/releases/2021/01/210119102846.htm

2. Designing Customized 'Brains' for Robots

Contemporary robots can move quickly. "The motors are fast, and they're powerful," says Sabrina Neuman. Yet in complex situations, like interactions with people, robots often don't move quickly. "The hang up is what's going on in the robot's head," she adds. Perceiving stimuli and calculating a response takes a "boatload of computation," which limits reaction time, says Neuman, who recently graduated with a PhD from the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). Neuman has found a way to fight this mismatch between a robot's "mind" and body. The method, called robomorphic computing, uses a robot's physical layout and intended applications to generate a customized computer chip that minimizes the robot's response time. The advance could fuel a variety of robotics applications, including, potentially, frontline medical care of contagious patients. There are three main steps in a robot's operation, according to Neuman. The first is perception, which includes gathering data using sensors or cameras. The second is mapping and localization: "Based on what they've seen, they have to construct a map of the world around them and then localize themselves within that map," says Neuman. The third step is motion planning and control -- in other words, plotting a course of action. These steps can take time and an awful lot of computing power. "For robots to be deployed into the field and safely operate in dynamic environments around humans, they need to be able to think and react very quickly," says Plancher. "Current algorithms cannot be run on current CPU hardware fast enough." Neuman adds that researchers have been investigating better algorithms, but she thinks software improvements alone aren't the answer. "What's relatively new is the idea that you might also explore better hardware." That means moving beyond a standard-issue CPU processing chip that comprises a robot's brain -- with the help of hardware acceleration. Hardware acceleration refers to the use of a specialized hardware unit to perform certain computing tasks more efficiently. A commonly used hardware accelerator is the graphics processing unit (GPU), a chip specialized for parallel processing. These devices are handy for graphics because their parallel structure allows them to simultaneously process thousands of pixels. "A GPU is not the best at everything, but it's the best at what it's built for," says Neuman. "You get higher performance for a particular application." Most robots are designed with an intended set of applications and could therefore benefit from hardware acceleration. That's why Neuman's team developed robomorphic computing. The system creates a customized hardware design to best serve a particular robot's computing needs. The user inputs the parameters of a robot, like its limb layout and how its various joints can move. Neuman's system translates these physical properties into mathematical matrices. These matrices are "sparse," meaning they contain many zero values that roughly correspond to movements that are impossible given a robot's particular anatomy. (Similarly, your arm's movements are limited because it can only bend at certain joints -- it's not an infinitely pliable spaghetti noodle.) The system then designs a hardware architecture specialized to run calculations only on the non-zero values in the matrices. The resulting chip design is therefore tailored to maximize efficiency for the robot's computing needs. And that customization paid off in testing. Hardware architecture designed using this method for a particular application outperformed off-the-shelf CPU and GPU units. While Neuman's team didn't fabricate a specialized chip from scratch, they programmed a customizable field-programmable gate array (FPGA) chip according to their system's suggestions. Despite operating at a slower clock rate, that chip performed eight times faster than the CPU and 86 times faster than the GPU.

"I was thrilled with those results," says Neuman. "Even though we were hamstrung by the lower clock speed, we made up for it by just being more efficient." A Researcher sees widespread potential for robomorphic computing. "Ideally we can eventually fabricate a custom motion-planning chip for every robot, allowing them to quickly compute safe and efficient motions," he says. "I wouldn't be surprised if 20 years from now every robot had a handful of custom computer chips powering it, and this could be one of them." Neuman adds that robomorphic computing might

allow robots to relieve humans of risk in a range of settings, such as caring for covid-19 patients or manipulating heavy objects. Neuman next plans to automate the entire system of robomorphic computing. Users will simply drag and drop their robot's parameters, and "out the other end comes the hardware description. I think that's the thing that'll push it over the edge and make it really useful."

Source https://www.sciencedaily.com/releases/2021/01/210121150958.htm

Mechanical Engineering

3. A Display That Completely Blocks Off Counterfeits

Despite the anticounterfeiting devices attached to luxury handbags, marketable securities, and identification cards, counterfeit goods are on the rise. There is a demand for the next-generation anticounterfeiting technology -- that surpasses the traditional ones -- that are not easily forgeable and can hold various data. A POSTECH research team, led by Professor Junsuk Rho of the departments of mechanical engineering and chemical engineering, Ph.D. candidates Chunghwan Jung of the Department of Chemical Engineering and Younghwan Yang of the Department of Mechanical Engineering, have together succeeded in making a switchable display device using nanostructures that is capable of encrypting full-colour images depending on the polarization of light. The new device developed by the research team was produced with a microstructure about one thousand times thinner than a strand of hair which is called a metasurface. It is known that various colours can be expressed through a uniformly arranged microstructures within the metasurface. Because the microstructures produced this time have very small pixels, they boast high resolution (approximately 40,000 dpi) and wide viewing angle while being thin, which allows it to be produced in the form of stickers. In addition, unlike previous studies that focused on the expression of various colors, in this study, the on and off states can be adjusted according to the polarization of the incident light. This new device displays full-colour images during the on state and shows no images in the off state. Besides having the ability to turn on and turn off an image, the device can switch between different images. Specifically, by arranging three consecutive nanostructures, it achieves higher colorization rate than the previous studies. The researchers properly configured a total of 125 types of structures to encode a full-colour image and proved through experiments that it completely turns off according to the polarization. This feature can be utilized in real life as an anti-forgery device. For example, it can be designed into a security label that appears to be a simple colour image to the naked eye, but reveals the serial number when a special filter is used. Moreover, by utilizing its ultrahigh resolution feature and inserting high-capacity data security algorithm, it can be used as a new security device that can replace the traditional labeling method. Chunghwan Jung, the first author of the paper, commented, "This new device is practically impossible to forge because it requires an electron microscope with magnification capacity of several thousand and a nanometer-scale production equipment." "This device is an ultra-high-resolution device-type display that can turn on and turn off full-color images according to the polarization component of the incident light," remarked the corresponding author Professor Junsuk Rho who led the study. "These displays can store multiple images simultaneously and can be applied to in optical cryptography."

Source https://www.sciencedaily.com/releases/2021/01/210121131724.htm

Chemical Engineering

4. New Eco-Friendly Way to Make Ammonia Could be Boon for Agriculture, Hydrogen Economy

Chemical engineers at UNSW Sydney have found a way to make 'green' ammonia from air, water and renewable electricity that does not require the high temperatures, high pressure and huge infrastructure currently needed to produce this essential compound. And the new production method -- demonstrated in a laboratory-based proof of concept -- also has the potential to play a role in the global transition towards a hydrogen economy, where ammonia is increasingly seen as a solution to the problem of storing and transporting hydrogen energy. In a paper the authors from UNSW and University of Sydney say that ammonia synthesis was one of the critical achievements of the 20th century. When used in fertilisers that quadrupled the output of food crops, it enabled agriculture to sustain an ever-expanding global population. But since the beginning of the 1900s when it was first manufactured on a large scale, production of ammonia has been energy intensive -- requiring temperatures higher than 400oC and pressures greater than 200atm -- and all powered by fossil fuels. Dr Emma Lovell, a co-author on the paper from UNSW's School of Chemical Engineering, says the traditional way to make ammonia -- known as the Haber-Bosch process -- is only cost-effective when produced on a massive scale due to the huge amounts of energy and expensive materials required. "The current way we make ammonia via the Haber-Bosch method produces more CO2 than any other chemical-making reaction," she says. "In fact, making ammonia consumes about 2 per cent of the world's energy and makes 1 per cent of its CO2 -- which is a huge amount if you think of all the industrial processes that occur around the globe." Dr Lovell says in addition to the big carbon footprint left by the Haber-Bosch process, having to produce millions of tonnes of ammonia in centralised locations means even more energy is required to transport it around the world, not to mention the hazards that go with storing large amounts in the one place. She and her colleagues therefore looked at how to produce it cheaply, on a smaller scale and using renewable energy.

A co-researcher says trying to convert atmospheric nitrogen (N2) directly to ammonia using electricity "has posed a significant challenge to researchers for the last decade, due to the inherent stability of N2 that makes it difficult to dissolve and dissociate." Dr Jalili and his colleagues devised proof-of-concept lab experiments that used plasma (a form of lightning made in a tube) to convert air into an intermediary known among chemists as NOx -- either NO2- (nitrite) or NO3- (nitrate). The nitrogen in these compounds is much more reactive than N2 in the air. "Working with our University of Sydney colleagues, we designed a range of scalable plasma reactors that could generate the NOx intermediary at a significant rate and high energy efficiency," he says. "Once we generated that intermediary in water, designing a selective catalyst and scaling the system became significantly easier. The breakthrough of our technology was in the design of the high-performance plasma reactors coupled with electrochemistry." Professor Patrick Cullen, who led the University of Sydney team, adds: "Atmospheric plasma is increasingly finding application in green chemistry. By inducing the plasma discharges inside water bubbles, we have developed a means of overcoming the challenges of energy efficiency and process scaling, moving the technology closer to industrial adoption." Scientia Professor Rose Amal, who is co-director of ARC Training Centre for Global Hydrogen Economy, says in addition to the advantages of being able to scale down the technology, the team's 'green' method of ammonia production could solve the problem of storage and transport of hydrogen energy. "Hydrogen is very light, so you need a lot of space to store it, otherwise you have to compress or liquify it," says Professor Amal. "But liquid ammonia actually stores more hydrogen than liquid hydrogen itself. And so there has been increasing interest in the use of ammonia as a potential energy vector for a carbon-free economy." Professor Amal says ammonia could potentially be made in large quantities using the new green method

ready for export. "We can use electrons from solar farms to make ammonia and then export our sunshine as ammonia rather than hydrogen.

Source https://www.sciencedaily.com/releases/2021/01/210121091332.htm

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Electrical Engineering

5. Highly Efficient Grid-Scale Electricity Storage at Fifth of Cost

Researchers in WMG at the University of Warwick, in collaboration with Imperial College London, have found a way to enhance hybrid flow batteries and their commercial use. The new approach can store electricity in these batteries for very long durations for about a fifth the price of current technologies, with minimal location restraints and zero emissions. The researchers enhanced three hybrid flow cells using nitrogen doped graphene (exposed to nitrogen plasma) in a binder-free electrophoresis technique (EPD). Wind and solar power are increasingly popular sources for renewable energy. Unfortunately, intermittency issues keep them from connecting widely to the National grid. One potential solution to this problem involves in the deployment of long-duration battery technology, such as the redox flow battery. Despite its great promise the current costs of this system are a key determining factor to real-world adoption. Now WMG researchers have found a way of enhancing hybrid flow batteries or regenerative fuel cell (RFC) technology that could store electricity for very long durations for about one-fifth the cost of current storage technologies, with flexibility in siting and with minimal environmental impact. The technology combines carbon-based electrodes with economically sourced electrolytes, (manganese or sulphur, which are abundant chemicals in the planet) by means of a simple and yet highly effective electrophoretic deposition of nano-carbon additives (nitrogen-doped graphene) that enhance the electrode durability and performance significantly in highly acidic or alkaline environments. Dr Barun Chakrabarti, a Research Fellow in WMG at the University of Warwick and one of the lead researchers said: "This EPD technique is not only simple but also improves the efficiencies of three different economical hybrid flow batteries thereby increasing their potential for widespread commercial adoption for grid-scale energy storage." The hybrid flow battery's total chemical cost is about 1/30th the cost of competing batteries, such as lithium-ion systems. These batteries are also extremely useful for grid-scale load levelling applications as their design is very flexible due to their unique feature of sizing their power independently of their energy. The energy density of a hybrid flow battery, especially the polysulphide/air system (S-Air), is 500 times higher than pumped hydroelectric storage. It is also so much more compact and can be placed near any renewable generation.

Source https://www.sciencedaily.com/releases/2021/01/210122112306.htm

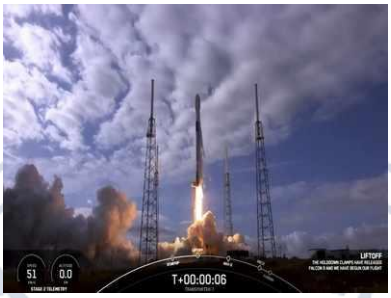
6. World's Fastest Optical Neuromorphic Processor

An international team of researchers led by Swinburne University of Technology has demonstrated the world's fastest and most powerful optical neuromorphic processor for artificial intelligence (AI), which operates faster than 10 trillion operations per second (TeraOPs/s) and is capable of processing ultra-large scale data. Published in the journal Nature, this breakthrough represents an enormous leap forward for neural networks and neuromorphic processing in general. Artificial neural networks, a key form of AI, can 'learn' and perform complex operations with wide applications to computer vision, natural language processing, facial recognition, speech translation, playing strategy games, medical diagnosis and many other areas. Inspired by the biological structure of the brain's visual cortex system, artificial neural networks extract key features of raw data to predict properties and behaviour with unprecedented accuracy and simplicity. The team achieved an exceptional feat in optical neural networks: dramatically accelerating their computing speed and processing power. The team demonstrated an optical neuromorphic processor operating more than 1000 times faster than any previous processor, with the system also processing record-sized ultra-large scale images -- enough to achieve full facial image recognition, something that other optical processors have been unable to accomplish. "This breakthrough was achieved with 'optical micro-combs', as was our world-record internet data speed reported in May 2020," says Professor Moss, Director of Swinburne's Optical Sciences Centre and recently named one of Australia's top research leaders in physics and mathematics in the field of optics and photonics by The Australian. While state-of-the-art electronic processors such as the Google TPU can operate beyond 100 TeraOPs/s, this is done with tens of thousands of parallel processors. In contrast, the optical system demonstrated by the team uses a single processor and was achieved using a new technique of simultaneously interleaving the data in time, wavelength and spatial dimensions through an integrated micro-comb source. Micro-combs are relatively new devices that act like a rainbow made up of hundreds of high-quality infrared lasers on a single chip. They are much faster, smaller, lighter and cheaper than any other optical source."In the 10 years since I co-invented them, integrated micro-comb chips have become enormously important and it is truly exciting to see them enabling these huge advances in information communication and processing. Micro-combs offer enormous promise for us to meet the world's insatiable need for information," Professor Moss says. "This processor can serve as a universal ultrahigh bandwidth front end for any neuromorphic hardware -- optical or electronic based -- bringing massive-data machine learning for real-time ultrahigh bandwidth data within reach," says co-lead author of the study, Dr Xu, Swinburne alum and postdoctoral fellow with the Electrical and Computer Systems Engineering Department at Monash University. "We're currently getting a sneak-peak of how the processors of the future will look. It's really showing us how dramatically we can scale the power of our processors through the innovative use of microcombs," Dr Xu explains. RMIT's Professor Mitchell adds, "This technology is applicable to all forms of processing and communications -- it will have a huge impact. Long term we hope to realise fully integrated systems on a chip, greatly reducing cost and energy consumption." "Convolutional neural networks have been central to the artificial intelligence revolution, but existing silicon technology increasingly presents a bottleneck in processing speed and energy efficiency," says key supporter of the research team, Professor Damien Hicks, from Swinburne and the Walter and Elizabeth Hall Institute. He adds, "This breakthrough shows how a new optical technology makes such networks faster and more efficient and is a profound demonstration of the benefits of cross-disciplinary thinking, in having the inspiration and courage to take an idea from one field and using it to solve a fundamental problem in another."

Source https://www.sciencedaily.com/releases/2021/01/210107112418.htm

Aerospace Engineering

7. India Test-Fires Rudram 1, its First Anti-Radiation Missile to Kill Enemy Radars



Nearly a fortnight after Elon Musk's Tesla entered India on January 8, SpaceX broke a world space record by launching 143 satellites in quick succession. The launch vehicle for the SpaceX record-breaking flight was the Falcon 9 and the mission was designated as Transporter-1. The lift-off at Cape Canaveral in Florida was at 8.31pm IST. The launch marks the first dedicated mission for SpaceX's SmallSat Rideshare Program, which enables small-satellite customers to book a ride to orbit with SpaceX directly. The 143 satellites launched on Sunday included commercial and government CubeSats, microsats, what are known as orbiter transfer vehicles and 10 Starlink satellites — the maximum number of spacecraft ever to be deployed in a single mission. This batch of Starlink satellites was the first in the constellation to be placed in the polar orbit. The nearly 90-minute deployment sequence of the satellites having different roles was nail-biting because they separated in a span of a few seconds and a minute. Onboard was also a spacecraft belonging to Nasa. With these satellites, SpaceX aims to provide near-global broadband internet coverage all over the world by 2021. About 10 minutes after lift-off, SpaceX recovered the first stage once again on the drone ship stationed in the Atlantic Ocean. Then, about an hour after liftoff, the payloads started deploying over the course of about 90 minutes. According to sources, SpaceX offered a very low price of $15,000 per kilogram for each satellite to be delivered to a polar sun-synchronous orbit.

Source https://timesofindia.indiatimes.com/world/us/spacex-launches-143-satellites-breaks-world-space-record/articleshow/80438989.cms

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8. A Better Pen-and-Ink System for Drawing Flexible Circuits

Conductive ink is a great tool for printing flexible electronic circuits on surfaces. But these inks can be costly, they do not work on some materials, and devices to apply them can plug up. Now, scientists report that they have developed inexpensive conductive inks for clog-free ballpoint pens that can allow users to "write" circuits almost anywhere -- even on human skin. Flexible electronics are widely used in applications such as biosensors, electronic skin and energy storage. Recent advances to produce such devices include pens that can draw circuits on surfaces, without the need for a printer. These pens can write on a variety of textures, and some can even draw on rough or irregular surfaces unsuitable for printing. However, it's difficult to make ballpoint pens that maintain good circuit-writing performance because the tips can clog. Another challenge is that the metal inks typically used in these systems are expensive to make. And it's unclear how stable these pens and inks are over time. So Yu Liao, Jun Qian and colleagues set out to design a cheap and effective pen-and-ink system. Building on prior work, the scientists developed a water-based ink containing conductive carbon particles composed of graphene nanosheets, multiwalled carbon nanotubes and carbon black. Maleic anhydride modified rosin resin was added as a binder to reduce the ink's solid content and viscosity, and xanthan gum was added to stabilize the dispersion so the carbon wouldn't settle out of the ink. The researchers optimized viscosity and the size of the conductive particles relative to the pen tip to create a system that provided stable and smooth writing performance on both flat and irregular surfaces -- even a loofah. Circuits drawn on paper with the pen withstood multiple cycles of folding without deterioration. The ink remained stable after sitting for 12 hours, released no harmful gases during use and cost much less than others reported in the literature, the researchers note. The pens could be used to draw flexible, wearable electronic devices on soft substrates or human skin.

Source https://www.sciencedaily.com/releases/2021/01/210106133025.htm

9. An Anode-Free Zinc Battery That Could Someday Store Renewable Energy

Renewable energy sources, such as wind and solar power, could help decrease the world's reliance on fossil fuels. But first, power companies need a safe, cost-effective way to store the energy for later use. Massive lithium-ion batteries can do the job, but they suffer from safety issues and limited lithium availability. Now, researchers have made a prototype of an anode-free, zinc-based battery that uses low-cost, naturally abundant materials. Aqueous zinc-based batteries have been previously explored for grid-scale energy storage because of their safety and high energy density. In addition, the materials used to make them are naturally abundant. However, the rechargeable zinc batteries developed so far have required thick zinc metal anodes, which contain a large excess of zinc that increases cost. Also, the anodes are prone to forming dendrites -- crystalline projections of zinc metal that deposit on the anode during charging -- that can short-circuit the battery. Yunpei Zhu, Yi Cui and Husam Alshareef wondered whether a zinc anode was truly needed. Drawing inspiration from previous explorations of "anode-free" lithium and sodium-metal batteries, the researchers decided to make a battery in which a zinc-rich cathode is the sole source for zinc plating onto a copper current collector. In their battery, the researchers used a manganese dioxide cathode that they pre-intercalated with zinc ions, an aqueous zinc trifluoromethanesulfonate electrolyte solution and a copper foil current collector. During charging, zinc metal gets plated onto the copper foil, and during discharging the metal is stripped off, releasing electrons that power the battery. To prevent dendrites from forming, the researchers coated the copper current collector with a layer of carbon nanodiscs. This layer promoted uniform zinc plating, thereby preventing dendrites, and increased the efficiency of zinc plating and stripping. The battery showed high efficiency, energy density and stability, retaining 62.8% of its storage capacity after 80 charging and discharging cycles. The anode-free battery design opens new directions for using aqueous zinc-based batteries in energy storage systems, the researchers say.

Source https://www.sciencedaily.com/releases/2021/01/210120085052.htm

10. No more needles for diagnostic tests?

Oftentimes, doctors use blood samples to check for biomarkers of disease: antibodies that signal a viral or bacterial infection, such as SARS-CoV-2, the virus responsible for COVID-19; or cytokines indicative of inflammation seen in conditions such as rheumatoid arthritis and sepsis. These biomarkers aren't just in blood, though. They can also be found in the dense liquid medium that surrounds our cells, but in a low abundance that makes it difficult to be detected. Until now. Engineers at the McKelvey School of Engineering at Washington University in St. Louis have developed a microneedle patch that can be applied to the skin, capture a biomarker of interest and, thanks to its unprecedented sensitivity, allow clinicians to detect its presence. The technology is low cost, easy for a clinician or patients themselves to use, and could eliminate the need for a trip to the hospital just for a blood draw. The research, from the lab of Srikanth Singamaneni, the Lilyan & E. Lisle Hughes Professor in the Department of Mechanical Engineering & Material Sciences, was published online Jan. 22 in the journal *Nature Biomedical Engineering*. In addition to the low cost and ease of use, these microneedle patches have another advantage over blood draws, perhaps the most important feature for some: "They are entirely pain-free," Singamaneni said. Finding a biomarker using these microneedle patches is similar to blood testing. But instead of using a solution to find and quantify the biomarker in blood, the microneedles directly capture it from the liquid that surrounds our cells in skin, which is called dermal interstitial fluid (ISF). Once the biomarkers have been captured, they're detected in the same way -- using fluorescence to indicate their presence and quantity. ISF is a rich source of biomolecules, densely packed with everything from neurotransmitters to cellular waste. However, to analyze biomarkers in ISF, conventional method generally requires extraction of ISF from skin. This method is difficult and usually the amount of ISF that can be obtained is not sufficient for analysis. That has been a major hurdle for developing microneedle-based biosensing technology. Another method involves direct capture of the biomarker in ISF without having to extract ISF. Like showing up to a packed concert and trying to make your way up front, the biomarker has to manoeuvre through a crowded, dynamic soup of ISF before reaching the microneedle in the skin tissue. Under such conditions, being able to capture enough of the biomarker to see using the traditional assay isn't easy. But the team has a secret weapon of sorts: "plasmonic-fluors," an ultrabright fluorescence nanolabel. Compared with traditional fluorescent labels, when an assay was done on microneedle patch using plasmonic-fluor, the signal of target protein biomarkers shined about 1,400 times as bright and become detectable even when they are present at low concentrations. "Previously, concentrations of a biomarker had to be on the order of a few micrograms per milliliter of fluid," Zheyu a lead author of the paper, said. That's far beyond the real-world physiological range. But using plasmonic-fluor, the research team was able to detect biomarkers on the order of picograms per milliliter. "That's orders of magnitude more sensitive," Ryan said. These patches have a host of qualities that can make a real impact on medicine, patient care and research. They would allow providers to monitor biomarkers over time, particularly important when it comes to understanding how immunity plays out in new diseases. For example, researchers working on COVID-19 vaccines need to know if people are producing the right antibodies and for how long. "Let's put a patch on," Singamaneni said, "and let's see whether the person has antibodies against COVID-19 and at what level." Or, in an emergency, "When someone complains of chest pain and they are being taken to the hospital in an ambulance, we're hoping right then and there, the patch can be applied," Jingyi Luan, a student who recently graduated from the Singamaneni lab and one of the lead authors of the paper, said. Instead of having to get to the hospital and have blood drawn, EMTs could use a microneedle patch to test for troponin, the biomarker that indicates myocardial infarction. For people with chronic conditions that require regular monitoring, microneedle patches could eliminate unnecessary trips to the hospital, saving money, time and discomfort -- a lot of discomfort. The patches are almost pain-free. "They go about

400 microns deep into the dermal tissue," Singamaneni said. "They don't even touch sensory nerves." The implications are vast -- and Singamaneni's lab wants to make sure they are all explored. Current approaches for such evaluation require the isolation of local tissues and do not allow successive and continuous inspection. Singamaneni and Scheller are developing a better platform to achieve long term monitoring of local biomarker concentration.

Source https://www.sciencedaily.com/releases/2021/01/210123091028.htm

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ENGINEERING INNOVATION IN INDIA

Indian Reactor Connected to the Grid

Unit 3 of the Kakrapar nuclear power plant in India's Gujarat state has been connected to the electricity grid. The reactor - the country's first indigenously-designed 700 MWe pressurised heavy water reactor (PHWR) - achieved criticality in July last year

Kakrapar 3 was synchronised with the grid at 11.37am on 10 January. "A true example of indigenous technology developed and built in India with 15 more such units to follow in fleet mode," Dr Anil Kakodkar, former secretary of the Department of Atomic Energy, was quoted as saying. In April 2007, the Indian government approved plans for the first four of eight planned 700 MWe PHWR units: Kakrapar units 3 and 4 and Rajasthan units 7 and 8, to be built by Hindustan Construction using indigenous technology. In mid-2009, construction approval was confirmed, and late in 2009 the finance for them was approved. Site works at Kakrapar were completed by August 2010. First concrete for Kakrapar 3 and 4 was in November 2010 and March 2011, respectively, after Atomic Energy Regulatory Board (AERB) approval. The AERB approved Rajasthan 7 and 8 in August 2010, and site works then began. First concrete for those units was in July 2011. Construction had been expected to take 66 months. India plans to put 21 new nuclear power reactors - including 10 indigenously designed PHWRs - with a combined generating capacity of 15,700 MWe into operation by 2031, the Department of Atomic Energy announced in January 2019. Kakrapar 1 and 2 - both Indian-designed 220 MWe PHWRs - entered commercial operation in 1993 and 1995 respectively

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