INDIAN NATIONAL ACADEMY OF ENGINEERING

E-Newsletter

Vol. XIII, Issue 3, October 2022

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

Academy News (Covering period from June 1, 2022 to September 30, 2022)

EVENTS

16th National Frontiers of Engineering (NatFoE) Symposium, 2022

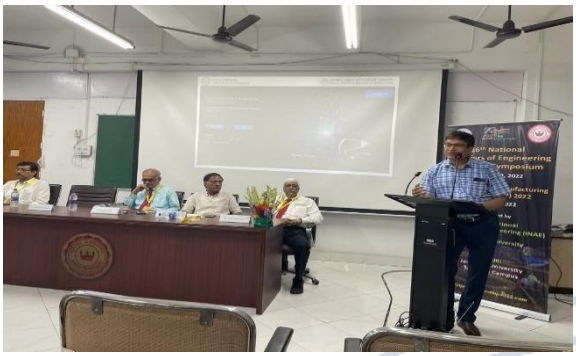
The Symposium on National Frontiers of Engineering (NatFOE) is one of the flagship events of INAE since 2006. The main objective of the event is to encourage Young Engineers (ages ~27-45) from industry, universities, and R&D labs to discuss leading-edge research and technical work across a range of engineering fields. The Indian National Academy of Engineering (INAE) organized the 16th National Frontiers of Engineering Symposium (NatFoE) jointly with Jadavpur University and in collaboration with IIT Kharagpur on 18th and 19th June 2022. This annual flagship event of INAE was organized at the Salt Lake campus of the Jadavpur University and was attended by young researchers across various academic institutions, R&D laboratories and industries as speakers and participants. It was a physical event organized after a long period of lockdown due to COVID pandemic and drew a huge enthusiasm from all quarters – participants, organizers and INAE Fellows and office bearers. For further details click here…..

Group Photograph of NatFoE Symposium on Day -1

Inaugural program of NatFoE 2022

Prof Indranil Manna delivering Presidential Address

The Abstract Booklet of NatFoE 2022 can be viewed by clicking here….



Inaugural Session in Progress

Prof Ashutosh Sharma, Chief Guest, being welcomed by Prof Indranil Manna, President INAE

Prof Ashutosh Sharma delivering Inaugural Address

Winners of the Poster Session being awarded by Prof Sivaji Chakravorti

Innovations in Manufacturing Practices (IMP) 2022

Changes in present day manufacturing reflect advancements in supply chain, markets, customer demands and engineering design. Growth of manufacturing sector of our country can significantly boost the national economy. Keeping this in mind, Indian National Academy of Engineering (INAE) and Jadavpur University, Kolkata (JU) organized a National Competition on Innovation in Manufacturing Practices (IMP 2022) at Jadavpur University, Kolkata on 20th June 2022 subsequent to the National Frontiers of Engineering Symposium 2022 to provide a platform for engineering students and startups to showcase innovations in manufacturing sector. After two years of pandemic, the event was organized in physical mode.

Participation was solicited in three categories – Undergraduate Students, Postgraduate Students and Startups. Total 55 innovations were submitted (22 in UG, 16 in PG and 6 in Startup categories) from different corners of our country. It was a two-round contest. The submitted entries were evaluated in the first round on the basis of their presentation video and submitted write-up.A jury board was constituted of three members, of whom two are INAE Young Engineer awardees and one is INAE Woman Engineer awardee. The jury board selected total 18 entries (six from each category) in the first round for final physical presentation on 20th June 2022. The final event was organized at UGC-HRDC Lecture Hall of Jadavpur University, Salt Lake Campus, Kolkata.

The event was inaugurated by Prof. Purnendu Ghosh, Vice President, INAE, and the participants were welcomed by Prof. Sivaji Chakravorti, Vice President, INAE. The Inaugural session was followed by three consecutive sessions for three categories. These sessions were chaired by three eminent academicians in the field of engineering & technology. However, the final event was attended by 12 participants (5 in UG, 4 in PG and 3 in Start-up categories) out of the selected 18 participating teams, mainly due to the sudden disruption in railway services at that time.

As the contest is a prestigious one, it was decided that only the deserving innovations will be awarded, and it was declared in the inaugural session. The jury members accordingly applied their judgment for conferment of the award. Finally, the jury board did not recommend any entry for the award in PG and Start-up categories. The first and the second prizes in the UG category went to two girl participants for their appreciable innovations. The awards were announced by Prof. Sivaji Chakravorti in the Valedictory Session of the event, after distribution of the participation certificates to the participants.

Two award winners in UG category with
Prof. Sivaji Chakravorti, Prof. Amitava Datta and Prof. Swarnendu Sen

SERB-INAE Conclave on 'SERB Digital Gaming Research Initiative'

Science and Engineering Research Board (SERB) launched "SERB Digital Gaming Research Initiative" to leverage Digital Gaming research and industry in India. Digital Gaming industry being a fast-growing sector globally, Government of India desires to achieve self-reliance in advanced Augmented Reality (AR)/ Virtual Reality (VR) technologies to create indigenous gaming platforms for a number of applications ranging from education to leisure with the backdrop of Indian Ethos for desktop and hand-held devices.

SERB has associated itself with the Indian National Academy of Engineering (INAE) for this project as a knowledge partner of SERB. Three broad directions have been identified under this initiative: R&D in Learning and Leisure Gaming Platforms; Immersive Game Prototypes, with a focus on Indian Culture & Values and Collaborative Technical Design Process: Creation of SERB Game Labs. A conclave was organized on July 20, 2022 in physical mode in New Delhi to brainstorm on the present scenario of Digital Gaming Research in India and to get recommendations based on which "Call for R&D Proposals" can be made. Experts from Academia, Start-ups and Industry participated in the event by invitation. Forty delegates joined the conclave from Academia, Industry and Start-ups besides SERB team and INAE team.

Delegates, President INAE, Secretary SERB and Ms Anju Bobby George, special invitee and SERB & INAE Team members present for the Conclave

For further details click here …..

SERB-INAE Hackathon 2022

The SERB-INAE Hackathon 2022 was organized jointly by SERB, INAE and Jadavpur University during 3-4 September 2022at Jadavpur University, Kolkata. The event wasfinancially supported by SERB and INAE. The objective of the event was to bring out the innovation and creative mindset amongst the undergraduate and postgraduate students from different engineering and science institutions of the country through their participation in this national-level, theme-based hackathon. This hackathon was a 30- hour non-stop event on four thematic areas and was housed in the School of Mobile Computing and IT Department in the SMCC Building of the Salt Lake Campus of Jadavpur University, which is located in a serene and quieter part of the city of Kolkata. For further details click here ….

Engineers Day Celebrations

Distinguished lecture on 'Towards Aatmanirbhar Bharat - Role of Engineers'

The Indian National Academy of Engineering (INAE) organised an online event to commemorate Engineers' Day celebrations on 15th September 2022, wherein Dr G Satheesh Reddy, FNAE, Scientific Advisor to Raksha Mantri, Ministry of Defence, Govt. of India, delivered a distinguished lecture on 'Towards Aatmanirbhar Bharat - Role of Engineers'. The event started with address of Prof Indranil Manna, President, INAE wherein he gave a brief about one of the country's greatest engineer, Sir Mokshagundam Visvesvaraya. He then introduced Dr G Satheesh Reddy and invited him to address the participants.

At the Commencement of his talk, Dr G Satheesh Reddy highlighted the importance of engineering in the prosperity of the nation, its role in social needs and in achieving the goal of Atmanirbhar Bharat- the vision of the Hon'ble Prime Minister. He stressed on the need of India becoming an economically powerful and prosperous country a strong academia and working with the mandate of 'Make in India to Make for the World'. He emphasised the need of India becoming more self-reliant in the fields of communication, Computer Applications, Defence Production, strategic materials and manufacturing and moving forward in the field of Artificial Intelligence and Machine Learning. He highlighted that currently India is home to as many as 75,000 start-ups by its youth primarily in the fields of engineering and technology. The event concluded after Question and Answers session. It was attended virtually by a large number of participants, INAE Fellows and dignitaries, to make it a successful event. Prof Indranil Manna, President, INAE thanked all the participants for attending this event. For the perusal of all interested, the recording of the event was uploaded on the INAE website. The link is as under.

https://www.youtube.com/watch?v=KkFpKLT_65Q

Address by Prof Indranil Manna, President, INAE

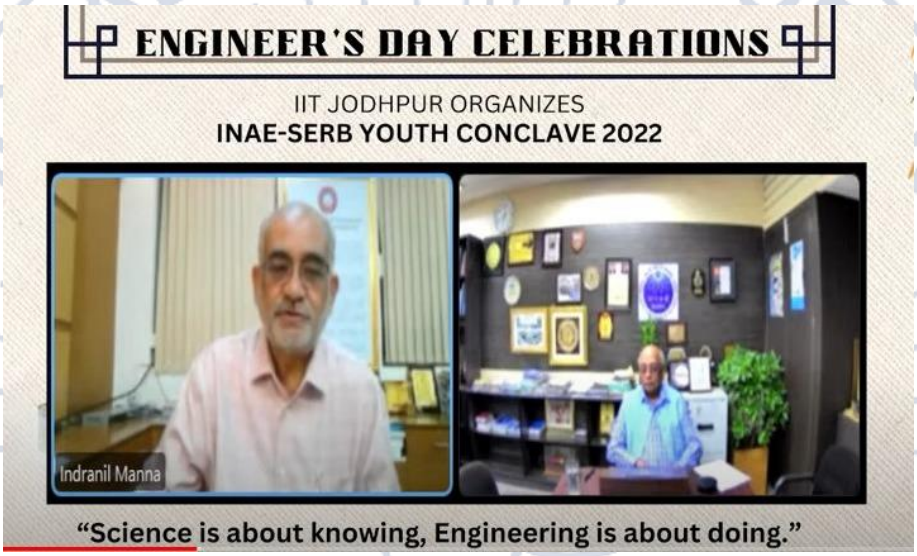
*Talk by **Dr G Satheesh Reddy,** FNAE, Scientific Advisor to Raksha Mantri, MoD, Govt. of India*

INAE -SERB Youth Conclave 2022 on Technology Self- Reliance

IIT Jodhpur organised Youth Conclave 2022 in collaboration with Indian National Academy of Engineering (INAE) and SERB at IIT Jodhpur campus from 15 Sept. to 18 September 2022. Youth conclave is an annual event promoted by INAE. The purpose of the event is to provide a platform to the country's youth to express their technological creativity and ingenuity and demonstrate their ability to innovate towards finding solutions that impact our collective future. In addition, participating in this event provides an excellent platform for students to interact with fellows of INAE and experts who have distinguished themselves with contributions in Engineering R&D, Industry and Academia. The theme of this fifth edition of Youth Conclave-2022 was: "Emerging Technologies for Sustainable Future". For further details click here…..

Welcome address Prof Santanu Chaudhury, Director IIT Jodhpur

Opening Remarks by Prof Purnendu Ghosh, Vice-President, INAE



Prof Indranil Manna, President, INAE delivering his Presidential Address during Inaugural function

Prof Devang V Khakhar, FNAE, Former Director of IIT Bombay, the Chief Guest delivering his Address

Dr R Chidambaram, Chairman, BoG, IIT Jodhpur and Former Principal Scientific Adviser to GoI delivering his Address

Participants at Game Jam Competition

Participants at Hackathon

Prof Indranil Manna, President, INAE delivering Address during Valedictory session

Prof Ashutosh Sharma presenting certificates to the Awardees

SERB-INAE 5-Day Workshop on "Innovation, Entrepreneurship and Start-Up for Young"

SERB-INAE sponsored 5-Day workshop (hybrid mode) on "Innovation, Entrepreneurship and Start-Up for Young" was organized by National Institute of Technology Mizoram from September 26-30, 2022. A total of 552 participants (512 online + 40 offline) had registered for the workshop from various institutions across the country. The institutions of the participants included NITs from all over the country including North East, Central Universities, State Universities and other affiliated colleges. The program was started on 26th September 2022 with formal inaugural ceremony. Prof. Prof. Venkappayya R Desai, Civil Engineering, IIT Kharagpur has graced the ceremony and enlightened the participants about the importance of workshop. Dr. Debasis Chatterjee, Founder & CEO, Cnnfiscore.com graced the occasion as Guest of Honor and shared his thoughts on the theme of the program. Prof. Saibal Chatterjee, Dean (Academics), NIT Mizoram & coordinator of the workshop motivated the participants emphasizing the importance of the workshop and advised the participants to benefit from the proceedings of workshop. To view the detailed schedule (speakers and topics) of 5-Day workshop, please click here ….

The participants have actively participated in all the sessions and interacted with the speakers. On the last day of the workshop, feedback was also collected from all the participants. The overall response was overwhelming. The weeklong workshop on Innovation, Entrepreneurship and Start-Up for Young was concluded with a formal valedictory function on 30th September 2022 from 3:30 PM onwards. Prof. Sivaji Chakravorti, Vice-President, INAE graced the occasion as the Chief Guest and expressed his views on the importance of the workshop and key takeaways. Various experts and the participants participated and expressed their opinion and feedback. The coordinators extended their invitation to all the participants to visit NIT Mizoram whenever possible and to work in collaboration.

Inaugural Session in Progress

Participants with Chief Guest of Valedictory Session

Group Photograph of Participants

Valedictory Session in Progress

INTERNATIONAL EVENTS

5th INAE-NAEK Workshop on Advanced Materials for Sustainable Development

Indian National Academy of Engineering (INAE), the only engineering Academy of the country represents India at the International Council of Academies of Engineering and Technological Sciences (CAETS). CAETS is an independent non-political, non-governmental, international organization of engineering and technological sciences academies, one-member academy per country. INAE conducts various joint Workshops with Member Academies of CAETS. One such collaborative workshop between INAE and NAEK has been undergoing since 2017. This year 5th INAE-NAEK Workshop on "Advanced Materials for Sustainable Development" was held on Aug 25-26, 2022 at Hotel Hyatt Regency, Kolkata in hybrid mode. The two themes of the workshop were "Materials for Quantum Computing" and "Machine Learning for development of Advanced Materials".

Over the course of two days, updates on R&D activities relating to advanced materials, especially those activities associated with Quantum Computing and Machine Learning were highlighted. This workshop provided a platform for future collaboration between researchers from both countries and also served as an important venue for vigorous exchanges and collaborations between Korean and Indian engineers. 16 experts representing Korea and India in the field of Materials for Quantum Computing and Machine Learning for Development of Advanced Materials sessions delivered the technical Presentations.

On 25 August 2022, the event started with the Inauguration session. Prof Sanghamitra Bandyopadhyay, Director, Indian Statistical Institute, Kolkata and Prof Debatosh Guha, FNAE & Professor, Institute of Radio Physics and Electronics, University of Calcutta delivered the Introductory Remarks. Subsequently, Prof Indranil Manna, President, INAE delivered the Welcome Address. During his Address, he gave a brief about INAE activities. He highlighted that India is pursuing the path of development and in words of Our Hon'ble Prime Minister, a goal of Atmanirbhar Bharat or Self-reliant India. In this path of development engineering and technology plays a vital role. We need a peer body like INAE to steer this initiative. Subsequently, Prof Jung-Hee Song, Vice-President, NAEK delivered her Welcome Address. In her Address, she highlighted the possibility of convergence between materials science and ICT under the theme of "Advanced Materials for Sustainable Development". The aim of this workshop is to provide and establish science and technology policy guidelines by examining major issues and technological development in the ICT and materials industries.

Two technical sessions pertaining to the theme "Materials for Quantum Computing" chaired by Prof Samit Kumar Ray, Professor, Department of Physics, IIT Kharagpur, India and Dr Seung-Cheol Lee, Director of Indo-Korea Science & Technology Center, KIST, South Korea were held. On 26 August 2022, two technical sessions pertaining to the theme "Machine Learning for development of Advanced Materials" which were chaired by Prof Sanghamitra Bandyopadhyay, Director, Indian Statistical Institute, Kolkata, India and Prof Tae-yeon Seong, Professor, Korea University were held. The Vote of Thanks was proposed by Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE. The event ended with the Concluding Session during which discussion and finalization of statement for future scope of collaboration were held. The workshop was attended physically by 50 participants and online by various participants. This workshop was an outstanding success.The event was also streamed Live on Youtube. The links are as under.

25th August 2022- https://www.youtube.com/watch?v=YxY13tYAqwQ&t=1239s
26th August 2022- https://www.youtube.com/watch?v=Eo9HbTa4KRM

Welcome Address by Prof Indranil Manna, President, INAE

Prof Jung-Hee Song, Vice-President, NAEK, Korea delivering Welcome Address

Prof Sanghamitra Bandyopadhyay, Director, ISI, Kolkata delivering Introductory Address

Vote of Thanks proposed by Lt Col Shobhit Rai (Retd), Deputy Executive Director, INAE

Indian Participants at the workshop at Kolkata

CAETS 2022 Annual Meeting and Convocation

This year CAETS 2022 Annual meetings and Conference was hosted by the National Academy of Technologies of France (NATF) in Versailles, near Paris, France. The International Conference on *"Engineering a better world: Breakthrough Technologies for Healthcare"* was held on Sep 27-28, 2022. INAE delegation led by Prof Indranil Manna, President, INAE participated in the subject event wherein the following two speakers from INAE delivered talks: Prof Sushmita Mitra, FNAE, Professor at the Machine Intelligence Unit (MIU), Indian Statistical Institute, Kolkata was a Speaker during *Technical Session 2 – The Foundations of Information and Communication Technologies (ICT) for Biology and Health* on September 27, 2022 on the topic " Intelligent Analysis of Biomedical Images". Prof GK Ananthasuresh**,** FNAE, Professor of Mechanical Engineering and the Dean of Mechanical Sciences at Indian Institute of Science Bangalore was a Speaker during *Technical Session 3 - Disruptive technologies and global R&D trends* on September 28, 2022 on the topic "Micromachinery for Mechano-diagnostics". Prof Jayanta Mukhopadhyay, Dept. of Computer Science and Engg., IIT Kharagpur was selected for conferment of the CAETS Communication prizes 2022 in the Category "High Potential Innovations" with a title of entry "iMediXcare Telemedicine System".

Prof Sushmita Mitra was interviewed during the event and the same can be viewed at the link given below.

https://e1.pcloud.link/publink/show?code=kZLv18Z5LcwTTmjzxStnvYy19sUqRK34nvy

Local Chapter Activities

ACTIVITIES under *Azadi ka Amrit Mahotsav* Initiative by INAE and its Local Chapters: A number of webinars were organized by INAE Local Chapters and INAE Headquarters during the quarter under the *Azadi ka Amrit Mahotsav Initiative* as given below:

- A virtual discussion meeting on '***Rare Earth - Plethora of Opportunities'*** was held on **August 11, 2022** over WebEx. The objective of this meeting was to deliberate on opportunities and challenges in this sector and how INAE can contribute towards this initiative. During the subject discussion meeting, a talk by Mr. Deependra Singh, Chairman and Managing Director, IREL (India) Limited, Department of Atomic Energy, Govt. of India was held followed by a discussion with experts. The session was chaired by Prof Indranil Manna, Co-Chair, DAE-INAE Consultative Committee & President, INAE.

- **INAE Mumbai Chapter**

(i) INAE Mumbai Chapter Webinar featuring Lecture by Prof Anuradha Narasimhan, Professor of Practice - IIT Bombay and Board Member – Africa Improved Foods, Rwanda and Frontier Nutrition, Bangladesh on "Entrepreneurship: To Be or Not to Be" was held on 1st July 2022

(ii) A DAE-BRNS Theme Meeting on "Advance Technologies in Dissimilar Metal Welding (DMW-2022) & DAE Technology Awareness Meet-II" was organized and conducted jointly by Bhabha Atomic Research Center, Mumbai, INAE, Mumbai Chapter and Power Beam Society of India (PSI) during 15th and 16thJuly 2022 at DAE Convention Centre, Mumbai. The theme meeting was organized in hybrid mode i.e. physical mode for local delegates and online mode for outstation delegates. The theme meeting DMW-2022 offered a common platform to the Engineers, manufacturers and Scientists working in the field of welding and joining technology to churn out the expertise in the field of advanced technologies such as EB Welding, Magnetic Pulse Welding, Diffusion bonding, friction stir welding, which are more suitable for welding dissimilar metals. The theme meeting was inaugurated with an introductory remark by Dr. Archana Sharma, FNAE, Director, BTDG, and Chairperson, DMW-2022 and Presidential address by Guest of Honour, Shri K. V. Ravi, Chief Executive, Nuclear Recycle Board. Chief Guest of the inaugural session Shri G. Nageswara Rao, Chairman, Atomic Energy Regulatory Board (AERB) addressed the dignitaries and participants of the theme meeting. The souvenir book of abstracts containing the invited talks and contributory papers of DMW-2022 was also released during the inaugural session by the Chief Guest.

Image 1: Release of Theme Meeting Souvenir during DMW-2022

The theme meeting key note address was delivered by Dr. G. K. Dey, Former Director, Materials Group, BARC on "Microstructural Development during welding". Prof. S. V. Kulkarni, (FNAE), Co-Chair, INAE, Mumbai Chapter, IIT Mumbai delivered the opening lecture of the theme meeting on "Electromagnetic Forming and Welding: Insights into Electromagnetic Forces, Eddy Currents, and Computational Methods". The technical programme included 18 invited talks from eminent speakers from IITs, DAE Units and entrepreneurs highlighting the ongoing research, challenges and future prospects in dissimilar metal welding. DMW-2022 was attended by 150 participants and the technical talks were broadcast live on https://www.dmw2022.com website. The contributions from participants of DAE and other academic institutes were covered in the Poster session. The two days theme meeting concluded with panel discussion and valedictory function. Dr. Ram Kumar Singh, FNAE, Co-Chair, Mumbai Local chapter addressed the dignitaries and participants in the concluding session and distributed the prize to the winners of DMW-2022 Best Poster Paper Award.

Prize distribution for DMW-2022 best Poster Paper Award

(iii) Technical talk at Electron Beam Centre, Navi Mumbai by Shri Krishna Gupta, Outstanding Scientist, Raja Ramanna Fellow, BARC-DAE, Former OSD, DAE Branch Secretariat, New Delhi, Former Project Director, GCNEP on "Indigenous Electron Accelerators for Agriculture and Industries" was held on 12th September 2022.

- **INAE Bangalore Chapter**

(i) INAE-BC Frontiers of Engineering Webinar Lecture Series featuring Lecture by Dr. Shishir N. Y. Kolathaya, Robert Bosch Center for Cyber Physical Systems (RBCCPS), IISc. Bangalore on "Learning for legged locomotion" was held on 23rd June 2022.He showed how reinforcement learning (RL) techniques can be used for realizing robust locomotion in custom built quadrupedal (four-legged) walking robots. He showed very interesting video demonstrations of three different types of walking robots Stoch1, Stoch2 and Stochlite that his team has developed that can learn to navigate different terrains. The talk elicited several questions and was attended by 15 people.

(ii) 13th "SAMVAAD – an IIT Dharwad-INAE Bangalore Chapter Lecture Series" featuring Lecture by Prof. Ned Mohan, Fellow: IEEE, Regents Professor, National Academy of Engineering, Electrical and Computer Engineering, University of Minnesota on "Power Engineering Education in the Age of Climate Crisis - A Holistic View" was held on 28th June 2022. Prof Ned Mohan presented a holistic view of Power Engineering Education in wake of climate change. For benefit of a wider audience, the talk was live-streamed on YouTube (https://youtu.be/31kAl8K33gU).

(iii) Last year, INAE-BC instituted Prof. Roddam Narasimha memorial lecture every year on his birthday (July 20th) to honour his contribution to Engineering and Technology. Starting this year, this event will be jointly organized by INAE-BC and NAL Bangalore. Professor Roddam Narasimha Inaugural Lecture jointly organized by CSIR-NAL, Bangalore and INAE Bangalore Chapter by Dr S. Somanath, Secretary Department of Space and Chairman, ISRO on "Challenges and Capability in Experimental and Computational Aerodynamics in Indian Space program" on 22nd July 2022. It was organized at NAL and was webcasted for those who were not able to attend. The event began with a welcome address from Introduction of speaker from Dr Venkatkrishnan, Chief Scientist, NAL. Following this Dr Somnath presented various Aerodynamic Challenges in Space vehicles and presented several case studies on how they overcame these challenges. INAE-BC was represented by Prof. M L Munjal, executive council member of INAE Bangalore Chapter and INSA Scientist, IISc Bangalore. The acting director of NAL Dr Bhowmik also addressed the gathering. Prof. Gopalakrishnan, Secretary, INAE-BC proposed the vote of thanks. The Lecture was attended by over 200 people with over 700 people heard the lecture through webcast.

(iv) 14th "SAMVAAD – an IIT Dharwad-INAE Bangalore Chapter Lecture Series" featuring Lecture by Prof. Jayant Haritsa, Department of Computational & Data Sciences, Indian Institute of Science, Bangalore on "The Latent Power of Absurd Ideas (aka Robust Query Processing)" was held

on 27th July 2022. The talk presented a first-ever provably robust database engine and was simultaneously streamed on YouTube (https://youtu.be/gK5PQt8fwpI) for the benefit of a wider audience including fraternities from technical institutes in Karnataka and CFTIs.

(v) 15th SAMVAAD Lecture (IIT Dharwad-INAE Bangalore Chapter Lecture Series) featuring Lecture by Prof. R.K. Shevgaonkar, FNAE, on "Engineering Education: Past, Present and Future" was held on 24th August 2022. Prof. R.K. Shevgaonkar presented an overview of engineering education from past to present and gave a glimpse of probable future education. For benefit of wider audience, the talk was live-streamed on YouTube (https://youtu.be/6mkcCkeIfQ4).

(vi) 16th SAMVAAD Lecture (IIT Dharwad-INAE Bangalore Chapter Lecture Series) featuring Lecture by Prof. Vijay Chandru, FNAE on "From Digital to Living Machines: Technological Reimagination of Our Future" was held on 28th September 2022.

- **INAE Delhi Chapter**

(i) INAE Delhi Chapter Seminar in association with the School of Interdisciplinary Research (SIRE), IIT Delhi organized a Lecture by Professor Dr Supratik Guha, Professor at the Pritzker School of Molecular Engineering at the University of Chicago and Argonne, National Laboratory, Chicago on “The Role of Materials Science in Information Processing Technologies” on 13th July 2022.

(ii) INAE Delhi Chapter: Industry Interaction with Mr Rajeev Sapra, Deputy General Manager (DGM) of Delhi Transco Limited (formerly, Delhi Vidyut Board) on "Evolution of Electric Vehicles and Charging Infrastructure in Delhi" was organized on 26th July 2022. Mr Rajeev Sapra gave an expert talk titled " Evolution of Electric Vehicles and Charging infrastructure in Delhi " on 26th July 2022 in EE committee room in IIT Delhi as part of industry interaction.The event was jointly organized by IEEE-VTS and INAE. Mr Rajeev Sapra is currently working as DeputyGeneral Manager of Delhi Transco limited. He is one of the leaders in developing the architecture of Electric Vehicles Charging Stations for the entire capital city of Delhi. Mr Sapra stressed in his talk about the aspects of practical engineering rather than academic knowledge. He emphasized the need for students to learn by building things on their own. In this regard, he also sharedhis experience about how the bidding and technical specifications of chargers for the capital city were decided. He also showed the probable sites of 100 chargers in and around Delhi. The technical specificationsof the chargers with 10 charging points were also discussed. The interaction with Mr Sapra was very informal with lot of questions from enthusiastic students. He invited students for a visit to the nearest substation in Munirka for a practical understanding and feel of the transmission system. Apart from this, Prof Sreyam Sinha from department of Electrical Engineering gave a detailed presentationon "Recent trends in wireless charging techniques". In this talk, he analyzed the inductive and capacitive wireless charging techniques for electric vehicles and made a comparison of them. He also showed the experimental prototype built for capacitive wireless charging taking care of misalignment and variable distance between the road and the chassis.

Photographs of Industry Interaction Session with Mr. Rajeev Sapra at IIT Delhi

There were about 30 graduate students and a few faculty members participated in-person in the interaction.The technical interaction was followed up by a lunch meeting in IIT Delhi Guest House with a few facultymembers. The technical interaction was also available to the online participants who could not attend in-person.

(iii) INAE Delhi Chapter Talk by Prof. Monisha Ghosh, Professor of Electrical Engineering, University of Notre Dame, USA and Former Chief Technology Officer, Federal Communications Commission, USA on "Spectrum Challenges for Next Generation Wireless Systems: the need for better coexistence" was held on 27th July 2022. The seminar of Prof. Monisha Ghosh discussed coexistent communication as a tool to meet the increasingcommunication throughput demands. The various challenges that must be overcome to achieve coexistencein the licensed and unlicensed mid-band spectrum were articulated. The presentation also highlighted the importance of unlicensed spectrum for NextG technologies and the benefits and difficulties of using unlicensed bands for licensed technologies like cellular communication. The talk strongly emphasized theimportance of monitoring deployed network performance with AI/ML research and for developing more accurate channel models. The seminar also featured case studies on measurement-based research on 5G millimeter-wave frequency bands (mmWaves), LTE-LAA coexistence in 5 GHz, and other topics. Further,the presentation also covered how the thermal effect makes it difficult to achieve sustained throughput overmmWaves. Additionally, the talk underscored the advantages of deploying 4G+LAA networks over 5G or4G networks. There were about 44 graduate students and a few faculty members participated in-person in the interaction. There were about 27 online attendees. The technical interaction was preceded by a lunch meeting with theinvited speaker in IIT Delhi Guest House with a few faculty members. Beyond the talk and question-answersession, the speaker interacted with a wide set of in-person attendees over a high tea organized in the school.


INAE Delhi Chapter Talk by Prof. Monisha Ghosh in prorgress

(iv) INAE Delhi Chapter Seminar featuring Lecture by Professor Dr Venkatesh Kodur, University Distinguished Professor and Director of the Centre on Structural Fire Engineering and Diagnostics at Michigan State University (MSU) on "Strategies for Mitigating Fire Hazard in Critical Transportation Infrastructure" was held on 27th July 2022.

(v) INAE Delhi Chapter Seminar featuring Lecture featuring Talk by Professor Dr Ravinder Dahiya, Professor of Electronics and Nanoengineering and EPSRC Research Fellow in the James Watt School of Engineering at University of Glasgow, UK on "Interactive Systems using High-Performance Flexible and Printed Electronic Skin" was held on 10th August 2022.

(vi) INAE Delhi Chapter Lecture featuring talk by Prof. Dr Suphiya Khan, Associate Professor and Founder of spinout company Drumlins Water Technologies Pvt Ltd at Banasthali Vidyapith on "The Art and Science of Academic Spinouts: A Journey from Water Research Lab to Drumlins Water Technologies" was held on 29th August 2022.

- **INAE Chennai Chapter**

(i) INAE Chennai Chapter Webinar featuring Lecture by Prof. Bhaskar Ramamurthi, FNAE, Dept. of Electrical Engineering, IIT Madras on “Towards an *Atmanirbhar* Telecom Network” was held on 8th July 2022. About 20 people attended the webinar. Prof. S. Narayanan introduced the speaker. In this webinar, the speaker described how India is moving towards the goal of a secure *Atmanirbhar* 4G and 5G telecom network. He said that even though India’s telecom network and subscriber base has grown by leaps and bounds during the last two decades, positively impacting the lives of all Indians, this has been achieved mostly by the imported network equipment and mobile phones. However, India, the world’s second largest telecom market, has to become a net contributor to global telecommunication technology and cannot remain a mere assembler and consumer. Design-led manufacturing of globally competitive products based on home-grown IP is the key to meeting this objective. Prof. Ramamurthi discussed how India is moving towards this objective. There was a lively discussion at the end of the webinar. Finally, Prof. Shaikh Faruque Ali presented the vote of thanks.

(ii) INAE Chennai Chapter Webinar by Prof. R. Krishnakumar, Institute Professor, Engineering Design Department, IIT Madras on “Human Heart: An Engineer’s Delight and a Clinician’s nightmare” was held on 20th August 2022. More than 30 people attended the webinar which also included a number of medical professionals. Prof. S. Narayanan, President of INAE Chennai Chapter presented briefly the activities of INAE Chennai Chapter and introduced the speaker. In this webinar, the speaker described how engineering can help in understanding the functioning of complex bio-organs with particular emphasis on the human heart. He explained how the human heart was often considered to be an engineer’s delight because of the complexities involved in modelling its material characteristics and it’s functioning and also mimicking the same in the laboratory environment for doing meaningful experiments which would help the doctor in diagnosis and treatment of heart diseases. At the same time, he also explained how the heart was a clinician’s nightmare being one of the most vital organs of the human body, the preservation of whose good health is of utmost importance for human life .

In his lecture, he said one in four deaths reported in India was due to cardiovascular diseases (CVD) and that South Asians accounted for one-fifth of all deaths attributed to a coronary artery disease. He explained how the heart was made up of composite materials and essentially was a composite structure with fibers running in opposite directions in a helical fashion inside and outside of the heart. He also explained how the electrical and the mechanical bio interactions elongate these fibers resulting in a twist. This torsion of the heart is responsible for ejection of blood rather than the pumping action of the heart which is the common belief. He also said how this action caused pulsations resulting in wave propagation. He said that the governing equation for such motion can be derived and solved using finite volume technique. He said that it was possible to create a heart model with the complete arterial and venous tree to create a digital twin of a patient. He said such "what if" parametric studies could help clinicians in taking informed decisions, whether it was the angle of attachment of an outflow graft in an LVAD or the site of attachment of a conduit in a Fontan operation improving very much, the chances of prognosis.

He emphasized that the future of simulation lay in developing robust patient-specific models of the heart, the complete arterial and venous tree, and the pulmonary vascular system. Modelling of electrophysiology of the heart and a three-way coupling with fluid and solid is a great challenge. The Center for Drug Evaluation and Research (CDER) of the Food and Drug Administration (FDA) of USA is currently using modeling and simulation to predict clinical outcomes. Unravelling the complexities of the human cardiovascular system is a work in progress across several centuries and countries and he said modern engineering tools could help immensely in the process. He said that digital twins mentioned earlier of human organs could help in deciding health of the organ, what type of treatment to be used and what would be the possible outcome of the treatment. Studies on simulation allowed one to enter clinical problem-specific or patient specific variables in the model and then test the various therapeutic options. He mentioned that thus clinicians were frequently looking for engineering solutions to better understand and solve difficult problems in the domain of blood flow, imaging and perhaps in developing newer artificial devices. He said that the future lay in progress of medical fraternity and engineering fraternity to work together holding hands for developing a healthy society. There was a lively discussion at the end of the webinar with a Question and Answer(Q&A) session in which both engineers and doctors participated. The webinar was moderated by Prof. Shaikh Faruque Ali, Treasurer, INAE Chennai Chapter who also proposed a formal vote of thanks.

(iii) INAE Chennai Chapter Webinar featuring Lecture by Prof (Dr) Chitra Rajagopal, Director, Centre of Excellence in Process Safety and Risk Management for a Hydrogen Economy, IIT Delhi on "Process Safety and Risk Management with focus on Hydrogen Safety" was held on 16th September 2022.

- **INAE Bhubaneswar Chapter**

(i) Tenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Prof. Farrokh Mistree, L.A. Comp Chair and Professor, School of Aerospace and Mechanical Engineering, University of Oklahoma, Norman, Oklahoma, USA on "*Atmanibhar Bharat* 2047 : On Moving Indian Higher Education Institutions up in the World Rankings" was held on 17th June 2022.

Key Points: India will celebrate its 100th year of independence in 2047. In this webinar the aim was to foster dialog on what Atmanibhar Bharat in 2047 will look like. It is hypothesized that transdisciplinary research and collaboration is key to developing the technology to achieve societal goals such as environmental justice, social justice and the like. He asserted that transdisciplinary research and collaboration is foundational to addressing not only cutting edge challenge problems but also in defining bleeding edge research opportunities that will position Indian academic institutions to become the virtual

destination of choice for people from around the world and thence catapult some academic institutions up in the world rankings. 96 people participated in the event.

You tube Link to the Video: https://www.youtube.com/watch?v=q1yqNGfRauE

(ii) Eleventh Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Prof. Sukumar Mishra, Professor, Department of Electrical Engineering, Indian Institute of Technology Delhi on "Distributed Energy Resources Rich Microgrid: Operation and Control" was held on 11th June 2022.

Key Points: Distributed energy resources (DERs), mostly solar and wind farms, are getting prime interest of the power system operators to overcome shortage of fossil fuels and for sustainable growth of the grid. It is necessary to understand the behaviour of voltage source inverters (VSIs) due to its importance in integrating DERs in the microgrids. Additionally, good understanding of transition from synchronous generators (SGs) to the VSIs is required to achieve smart operation and control of the power network. There are several methods available for effective operation of the VSIs, which are mostly categorized in three modes. Firstly, grid following (GFL) operation of VSIs to meet the voltage and frequency of the grid at the local point of common coupling. The phase lock loop (PLL) is crucial in GFL mode, which synchronizes VSI with the grid. It is difficult to synchronize the VSI through PLL, with a week grid. Therefore, GFL operation is more effective in SG rich and strong power system. Followed by the synchronization process, the DERs can transmit the power to satisfy their local load and the grid. Secondly, VSIs operate in grid supporting (GS) mode. Some of the popular GS functionalities are frequency, reactive, inertial and voltage support. Power regulatory authority of different countries impose grid codes for the operation of generating units comprising of DER in the distribution system. DER operator adheres to the grid codes to maintain operation of the VSI in GFL and GS mode. Last but not the least, grid forming (GFM) operation of the VSIs, which is effective in autonomous microgrid and week grid system. Unlike GFL mode, there is no requirement of PLL in GFM mode of operation and control of VSIs. The DERs in the micro-grid are operated in conventional droop to handle active and reactive power flows to maintain demand and generation balance of the system. The widely used conventional droop is P-f and Q-V droop (depends on the R/X of the network) which is used in power sharing among the DERs. The droop equation for low R/X network is modified for proper sharing of power among the DERs. The choice of droop coefficient of the DERs is a critical task as it is highly motivated by the economics of the plant as well as the network parameters. 64 people participated in the webinar.

You tube Link to the Video: https://youtu.be/emXKhfgiEl8

(iii) Twelfth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar by Prof. Barada Kanta Mishra, Director IIT Goa on "Discrete Element Analysis of Particulate Systems" was held on 9th July 2022.

Key Points: Particles are ubiquitous—avalanches, coating, powder mixing, optoelectronic device making, etc., involve particles. It is estimated that 70% of industrial processes involve particulate material of some form or other. Surprisingly though, not much is understood about this exciting class of material, mainly due to the complex behavior that develops when many particles interact. However, simulation of particulate systems using mathematical modeling tools has been gaining ground. As a result, it has been increasingly used to design, scale-up, improving process efficiency, debottlenecking, etc. I have successfully used the discrete element method (DEM) to analyze various particulate systems covering both theoretical and practical aspects. Here I will mainly discuss three topics of industrial

importance: (i) Breakage of particles, (ii) breakage of agglomerates, and (iii) mixing and segregation of particles. I will illustrate how DEM simulations capture the underlying physical phenomena of particulate systems while providing a better understanding of the underlying principles governing the processes. 46 people participated in the webinar.

You tube Link to the Video: https://youtu.be/DD38JoN30qA

(iv) Thirteenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar by Prof. Ashutosh Dutta, Chief 5G Strategist and Fellow at Johns Hopkins University Applied Physics Labs and Chair of Electrical and Computer Engineering for Engineering Professional Program at JHU on "5G Networks and Security – Opportunities and Challenges" was held on 13th July 2022.

Key Points: Software Defined Networking (SDN) and Network Function Virtualization (NFV) are the key pillars of future networks, including 5G and beyond that promise to support emerging applications such as enhanced mobile broadband, ultra-low latency, massive sensing type applications while providing the resiliency in the network. While NFV and SDN open up the door for flexible networks and rapid service creation, these also offer both security opportunities while also introducing additional challenges and complexities, in some cases. With the rapid proliferation of 4G and 5G networks, operators have now started the trial deployment of network function virtualization, especially with the introduction of various virtualized network elements in the access and core networks. This talk addresses evolution of cellular technologies towards 5G but largely focuses on various security challenges and opportunities introduced by SDN/NFV and 5G networks and enablers such as Hypervisor, Virtual Network Functions (VNFs), SDN controller, orchestrator, network slicing, cloud RAN, edge cloud, and security function virtualization. This talk introduces a threat taxonomy for 5G security from an end-to-end system perspective, potential threats introduced by these enablers, and associated mitigation techniques. At the same time, some of the opportunities introduced by these pillars are also discussed. This talk also highlights some of the ongoing activities within various standards communities including open source consortiums, large scale testbeds, and illustrates a few deployment use case scenarios for security. 54 people participated in the webinar.

You tube Link to the Video: https://youtu.be/fPkotjmSxFU

(v) Fourteenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar by Prof. Gopalan Jagadeesh, Professor in the Department of Aerospace Engineering, Indian Institute of Science Bangalore on " Shocking - Yet True…" was held on 22nd July 2022.

Key Points: The phenomenon of "Shock Waves" has been historically associated with aerospace engineering and in particular with supersonic flight. Shock waves appear in nature, when different elements in a fluid approach one another with a velocity higher than the local speed of sound. These waves are also generated if massive energy dissipation takes place within ultra-short time in events like explosions. A number of methodologies/facilities to generate shock waves of requisite strength have been designed and indigenously built in the Laboratory for Hypersonic and Shockwave Research (LHSR) in Indian Institute of Science (IISc), Bangalore. Over the years, these facilities have facilitated very interesting interdisciplinary research programmes in IISc with participation of several faculty members from physics, chemistry, biology and materials engineering. Some of the novel techniques that will be discussed in this talk includes retractable aero-spikes, smart coatings, forward facing jets and concentrated energy deposition for reducing the aerodynamic drag around vehicles flying at hypersonic speeds. Concurrently, utilizing the remarkable ability of shock waves to instantaneously enhance the

pressure and temperature in the propagating medium, several innovative shock wave assisted techniques have been developed in LHSR. These include non-intrusive needleless vaccine delivery, cell transformation, Wound healing, bio-film destruction, sandal oil extraction, polyphenol enrichment in tea, metal texture modification, and preservative impregnation in bamboo. A broad overview of the recent Transdisciplinary shock wave research and technology development activities at LHSR will be presented in this lecture. 62 people participated in the webinar.

You tube Link to the Video: https://youtu.be/KjL7k8EvYg8

(vi) Fifteenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Prof. Janet Katherine Allen, John and Mary Moore Chair of Engineering and Professor of Industrial and Systems Engineering, The School of Industrial and Systems Engineering, The University of Oklahoma on "From Make in India to Design and Make in India" was held on 10th August 2022.

Key Points: On June 17, 2022 Farrokh Mistree talked, to members of the INAE (Bhubaneswar Chapter), about Atmanirbhar Bharat 2047 - On Moving Indian Academic Institutions up in the World Rankings. He stated that the Make in India mantra in the next 25 years should be augmented to Design AND Make in India. In the context of the Design and Make in India mantra he planned to highlight some of the opportunities embodied in the Industry 4.0 construct that is associated with manufacturing and introduce the Design Engineering 4.0 construct that complements the Industry 4.0 construct. Foundational to sustaining Design and Make in India is basic research. Accordingly, he touched upon the state of government funding of basic research and how it could be directed to further the Design and Make in India mantra. 48 people participated in the webinar. 48 people participated in the webinar.

You tube Link to the Video: https://youtu.be/2twU2345HUg

(vi) Sixteenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Prof. Laxmidhar Behera, Director, Indian Institute of Technology Mandi, Himachal Pradesh on "Development of Cognitive Robotic Systems: Challenges and future perspectives" was held on 9th September 2022.

Key Points: Robots have evolved from caged environments to be able to operate within sociable platforms. Warehouse automation, Smart Education, Healthcare and entertainment have played significant roles for such a transformation where robots behave more human-like. In this talk, some selected applications in warehouse automation will be presented. An example will be presented to illustrate if such robotic systems are really cognitive in real-sense! Next, the efficacy of imitation learning was demonstrated in the development of cognitive robotic systems. The challenges while naturalizing strong AI in robotic systems were enumerated. 64 people participated in the webinar.

You tube Link to the Video: https://youtu.be/SwVEN_8VEzM

(vii) Seventeenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Professor Bidyadhar Subudhi, School of Electrical Sciences, Indian Institute of Technology Goa on "Navigation and Control of Marine Vehicles" was held on 16th September 2022.

Key Points: Research on navigation and control of marine vehicles (unmanned surface vehicles and autonomous under water vehicles) has received increased attention for several obvious reasons such as understanding marine environment for scientific exploration and their interesting applications. Some of the applications include ocean survey, pipe-line inspection, environmental data gathering, sampling, bathymetric mapping and defence. However, these applications necessitate designing effective motion

control algorithms for marine vehicles. In view of accomplishing control design successfully there is a need of accurate representation of dynamics of marine vehicles involving hydrodynamic damping, Coriolis terms, mass and inertia terms. Control design for an autonomous under water vehicle is challenging owing to parametric uncertainties arising from hydrodynamic parameters and external disturbances due to variation in oceanic currents. In this talk, modelling, control design and real-time implementation of the control algorithms for autonomous under water vehicle will be discussed. 47 people participated in the webinar.

You tube Link to the Video: https://youtu.be/McEqHPfwLVY

(viii) Eighteenth Lecture of the Distinguished Lecture Series organised by INAE Bhubaneswar Chapter, jointly with SOA University and IMMT Bhubaneswar featuring Lecture by Professor Ashok Kumar Pradhan, FNAE, Senior Member, IEEE, Institute Chair Professor and Chairperson, Subir Choudhury School of Quality and Reliability, Indian Institute of Technology Kharagpur on "Importance of Precision-Time in Electric Grid: Availability and Usages" was held on 21st September 2022.

Key Points: Today timing is essential to a wide variety of network functions and equipment in electric grids. Precise and reliable time is now available at reasonable cost worldwide. The electric grid operates as a single, complex and massively interconnected synchronous system. What happens in one part of the grid affects operation elsewhere. Managing and controlling these interactions require a means to compare the status at one place and time with the condition all around at the same instant. Precise time and high-speed communications in the substations are the enabling technologies which make this practical. Highly accurate and free to access, GPS timing signals have been incorporated into wide variety of applications such as to improve system reliability, reduce operation costs, better understand power system operation, predict and prevent system-wide faults, test and verify operation of protective devices. This talk will explain some of these applications related to 'time' as important information, discuss sources and distribution of precise time, and help to understand how to apply commercially available products to synchronize power system equipment even in the presence of large-scale renewable sources. Scope of future technology in this domain will be also addressed. 54 people participated in the webinar.

You tube Link to the Video: https://youtu.be/i2w8-XYNOWU

- **INAE Kolkata Chapter**

(i) Physical mode - Engineers Day celebrations by INAE Kolkata Chapter featuring Lecture by Mr. Rabi Chowdhury, Managing Director (Generation), CESC Ltd on "Power Generation, Transmission and Distribution in Kolkata - Challenges and Solutions" was held on 15th September 2022.

- **INAE Hyderabad Chapter**

The first Dr. G. Padmanabham Memorial Lecture **was held on** 10th August 2022 at 10.30 hrs. **(**in hybrid mode**)** to commemorate the valuable contributions of late Dr. G. Padmanabham, Former Director, ARCI in the field of Science and Technology and was a Fellow of INAE. The venue of the said lecture was G.S. Bhattacharjee Seminar Hall, ARCI, Hyderabad. Prof. Indranil Manna, Vice Chancellor, BIT, Mesra delivered the said lecture on "Additive Manufacturing".

Important Meetings held during June 2022, July 2022, August 2022 and September 2022

List of Meetings in June 2022

Jun 3 Digital Platform Committee Meeting for discussing new AMC
Jun 7 Meeting on SERB Digital Gaming Research Initiative
Jun 15 Second Meeting for selection of INAE Young Innovator & Entrepreneur Award 2022
Jun 15 INAE Young Innovator & Entrepreneur Award 2022: Finalization of Result
Jun 15 EC-2022: Preliminary Meeting for Theme-2
Jun 15 Planning the conduct of 5th INAE-NAEK Workshop
Jun 17 34th Finance Committee Meeting
Jun 17 DRDO INAE Consultative Committee Meeting
Jun 20 Meeting on Landmark Compendium
Jun 21 EC-2022: Preliminary Meeting for Theme-2
Jun 23 143rd Governing Council meeting
Jun 23 Meeting of sub-committee for reviewing guidelines for INAE Forums
Jun 26 EC-2022: Preliminary Meeting for Theme-2
Jun 27 Meeting of sub-committee for reviewing guidelines for INAE Forums

List of Meetings in July 2022

Jul 1 Second Meeting of Sectional Committee VI
Jul 1 Webinar on "Entrepreneurship: To Be or Not to Be"
Jul 4 Second Meeting of Sectional Committee III
Jul 6 Second Meeting of Sectional Committee IX
Jul 7 Second Meeting of Sectional Committee II
Jul 8 Webinar on “Towards an *Atmanirbhar* Telecom Network”
Jul 8 Second Meeting of Sectional Committee VIII
Jul 9 Meeting reg EC- Finalisation of Speakers
Jul 9 Meeting of the Peer Committee on Technological Preparedness for dealing with National Disruptions
Jul 11 Second Meeting of Sectional Committee I
Jul 13 Second Meeting of Sectional Committee VII
Jul 13 Second Meeting of Sectional Committee VII
Jul 14 Second Meeting of Sectional Committee V
Jul 14 Meeting of the ES-V for Election of Fellows & Foreign Fellows & INAE Young Engineer Award
Jul 14 Second Meeting of Sectional Committee IV
Jul 14 Second Meeting of Sectional Committee V
Jul 15 Second Meeting of Sectional Committee X
Jul 15 To finalize draft of compendium on landmark achievements in engineering & technology
Jul 17 Meeting of Core Committee on Proposed Compendium on "Landmark Achievements in Engineering and Technology in Independent India"
Jul 27 39th Apex Committee meeting
Jul 27 Discussion on Landmark Compendium

List of Meetings in August 2022

Aug 2 Meeting with Secretary DST
Aug 3 Meeting of the Selection Committee for Election of Foreign Fellows
Aug 3 35th Finance Committee Meeting

Aug 3 34th Annual General Meeting (AGM) - Part A
Aug 4 To discuss compendium on Women Engineers in India Volume – 1
Aug 5 35th Finance Committee Meeting
Aug 11 Discussion Meeting on 'Rare Earth - Plethora of Opportunities'
Aug 12 Discussion on SERB Digital Gaming Initiative
Aug 16 INAE Young Engineer Award 2022: Presentation by Shortlisted Nominees
Aug 17 INAE Young Engineer Award 2022: Presentation by Shortlisted Nominees
Aug 17 INAE Young Engineer Award 2022: Result Discussion
Aug 18 Plan for raising INAE Corpus fund
Aug 20 Human Heart: An Engineer's Delight and a Clinician's nightmare
Aug 20 Youth Conclave 2022: Discussion meeting to plan the conduct of event
Aug 22 144th Governing Council Meeting on 22nd August 2022
Aug 25 Presentations for Selection of Abdul Kalam Technology Innovation National Fellowship on August 25, 2022
Aug 30 First Meeting for shortlisting of nominations for INAE Innovative Student Projects Award on August 30, 2022
Aug 31 Meeting on Landmark Compendium

List of Meetings in September 2022

Sep 1 Discussion on Landmark Compendium
Sep 1 Discussion on Corpus Generation for INAE
Sep 3 Postponement of 144th GC from 31st August 2022 to 3rd September 2022 (Saturday) to discuss deferred Agenda Items
Sep 4 Planning of invitations for EC-2022
Sep 12 Meeting to discuss the progress of EC-2022
Sep 12 Webinar on "Indigenous Electron Beam Accelerators for Agriculture and Industries"
Sep 13 Discussion Regarding AMC of INAE Digital Platform
Sep 15 Webinar on "Process Safety and Risk Management with focus on Hydrogen Safety"
Sep 15 Engineers' Day Lecture by Dr G Satheesh Reddy on 15th September 2022
Sep 21 Opening of Tenders: Renting out of INAE Office Space at Gurgaon
Sep 21 Presentation by Shortlisted Nominees for Innovative Student Projects Award 2022

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INTERNATIONAL/NATIONAL CONFERENCES/SEMINARS BEING ORGANIZED BY IITS/OTHER INSTITUTIONS

3rd International Conference on Smart Electronics and Communication ICOSEC 2022 -online and in-person on 20th to 22nd October 2022 at Trichy, Tamil Nadu,
https://conferencealerts.com/show-event?id=245269

International Conference & Exposition on Mechanical, Material and Manufacturing Technology - online and in-person on 28th to 29th October 2022 at Hyderabad, Telangana
https://conferencealerts.com/show-event?id=246096

International Conference on Advancement in Electronic Systems and Communication Technologies (ICAESCT 2022) Conference- online and in-person on 4th to 5th November 2022 at Visakhapatnam, Andhra Pradesh
https://conferencealerts.com/show-event?id=247050

Recent Advances in Modeling & Simulations Techniques in Engineering & Science (RAMSTES-2022) Conference - online and in-person on 9th to 11th November 2022 at Jaipur, Rajasthan.
https://conferencealerts.com/show-event?id=247954

Second International Conference on Innovations in Electronics and Communication Systems (ICIECS 2022) Conference - online and in-person on 24th to 26th November 2022 at Chennai, Tamilnadu,
https://conferencealerts.com/show-event?id=245899

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HONOURS AND AWARDS

1	Prof Herbert Gleiter, Prof Dr Dr hcmult, KIT, Institut für Nanotechnologie, Helmholtz, Germany, a Foreign Fellow of INAE was elected to be awarded the highly regarded Stookey Prize of Discovery for the year 2022. Moreover, the Chinese Academy of Science has decided to found - by the end of 2022 - a new and very large research center at Sheyang called the Herbert Gleiter International Laboratory (HGIL). This center will focus its work on a new kind of non-crystalline solids, so called nanoglasses. It will have a size of about 600 scientists. The HGIL is designed to co-operate strongly with research laboratories within China as well as from abroad. Prof Gleiter is in contact with several colleagues from India to initiate cooperations of that kind between the HGIL and groups from India.
2	Prof Mahesh Tandon, FNAE, Managing Director, Tandon Consultants Pvt. Ltd., New Delhi has been awarded the Life Time Achievement Award for the year 2020 for his outstanding contributions for Highway Engineering profession by Indian Roads Congress. The award was conferred during the Inaugural Function of the 81st Annual Session held on October 8, 2022 at Lucknow.

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NEWS OF FELLOWS

1	Prof Sanjit K. Mitra, a Foreign fellow of INAE and Distinguished Professor Emeritus of Electrical & Computer Engineering, University of California, USA has been elected a member of the Academia Europaea.
2	Dr. G. Satheesh Reddy, FNAE formerly Secretary DDR&D and Chairman DRDO, Ministry of Defence has been appointed as Scientific Adviser to Raksha Mantri.
3	Dr. Samir V. Kamat, FNAE formerly Distinguished Scientist and Director-General, Naval Systems & Materials, DRDO, has been appointed as Secretary, Department of Defence Research and Development (DRDO).
4	Prof M Balakrishnan, FNAE, Honorary Professor, CSE Department, IIT Delhi was inducted as an ACM Fellow during the last ACM Annual Award Ceremony.
5	Prof. Sankar K. Pal, FNAE, National Science Chair, SERB, Govt. of India; ISI Emeritus Professor; Center for Soft Computing Research, Indian Statistical Institute, Kolkata has been elected as the President of Indian Statistical Institute (ISI) for the term 2022-2024 and also Member, European Academy of Sciences & Arts.
6	Prof Yogesh M Joshi, FNAE, Department of Chemical Engineering, IIT Kanpur became the first Indian to be elected as a Fellow of the Society of Rheology.

News of INAE Staff:

Late Dr Pandurang Khankhoje, Maternal grandfather of Dr Geetanjali Sawhney, Senior Research Officer, INAE; Freedom Fighter, honoured by Lok Sabha Speaker, Shri Om Birla who unveiled his bust at Mexico

Lok Sabha Speaker Shri Om Birla, who led an Indian Parliamentary delegation to Mexico, unveiled a bust of freedom fighter Dr Pandurang Khankhoje, maternal grandfather of Dr Geetanjali Sawhney, Senior Research Officer at INAE Office at Chapingo University in Mexico on September 2, 2022. Speaking on this occasion, the Speaker recalled that Dr Pandurang Khankhoje was an outstanding Indian revolutionary, scholar, agricultural scientist and statesman who was among the founding fathers of the Ghadar Party. While contributing to the prosperity of agriculture in Mexico, he brought about socio-economic change in the lives of millions of people. Shri Birla hailed Khankhoje as a true inspiration for posterity who will continue to define Mexico's journey towards development. "At a time when martyrs like Dr Khankhoje are being remembered and efforts are being made in India to bring their life journey as an inspiration for others, we have made his memory lasting forever for the people of India and Mexico by paying our heartfelt tributes to him," the Speaker said.
Some news links on the occasion are given below:
https://www.dailypioneer.com/2022/india/birla-unveils-freedom-fighter-pandurang-khankhoje---s-bust-in-chapingo-university-in-mexico.html

https://theprint.in/world/lok-sabha-speaker-unveils-bust-of-pandurang-khankhoje-inaugurates-india-mexico-friendship-garden/1114248/

http://www.uniindia.com/news/india/lok-sabha-speaker-visits-mexico/2814303.html

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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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ENGINEERING AND TECHNOLOGY UPDATES

Civil Engineering

1. Developing a sustainable concrete substitute

Worcester Polytechnic Institute (WPI) researchers from the National Science Foundation (NSF) are working on how to improve and develop new functions for their Enzymatic Construction Material (ECM), a "living" low-cost negative-emission construction material they created to address one of the largest contributors to climate change -- concrete -- by providing what they refer to as "a pathway to repair or even replace [traditional] concrete in the future." They have already made their research available for commercial use through a start-up called Enzymatic, Inc.; this new funding will also allow them to: explore new avenues for ECM's use, including repairing cracks in different types of glass, such as eyeglass lenses, cell phone screens, and car windshields. In addition to their efforts to help mitigate the massive climate change impacts created by concrete, they plan to use the new funding to refine and optimize ECM and the processes to create it and expand its use to different materials. Biological enzymes are catalysts that drive chemical reactions. ECM is made through a process involving an enzyme known as carbonic anhydrase -- found in all living cells -- that has the unique ability to react with CO2 to rapidly remove the greenhouse gas from the atmosphere. This reaction creates calcium carbonate crystals, which serve as ECM's main ingredient. A sand slurry is also added, as well as a polymer, which holds the ECM together during its early stages, much like scaffolding does during the construction of a building. Through this process, ECM can "heal itself" and fix cracks or other imperfections that may develop over time, retaining its strength through as many as six self-healing cycles. Through extensive testing and experimentation, the research team found that ECM has "outstanding" compression strength, rivaling traditional mortar, making it strong enough to be used in the construction of buildings as compressive elements. It also does not require baking at high temperatures like a traditional brick does, and it can be made quickly, unlike the 28 days needed to cure concrete. ECM can also be produced at a low cost as the percentage of the enzymes is minute. This new NSF funding will help the team improve the processes that will allow for EMC to move more swiftly from the lab to construction sites. A new pathway for the material could also be used to fix cracked or fractured glass. The researchers plan to partner with organizations in Worcester, to create summer programs and after-school programs in which students will design a six-inch model building, make a mould for it using 3D printing, and build the structure out of ECM.

Source https://www.sciencedaily.com/releases/2022/09/220913110441.htm

2. Key element for a scalable quantum computer

Millions of quantum bits are required for quantum computers to prove useful in practical applications. The scalability is one of the greatest challenges in the development of future devices. One problem is that the qubits have to be very close to each other on the chip in order to couple them together. Researchers at Forschungszentrum Jülich and RWTH Aachen University have now come a significant step closer to solving the problem. They succeeded in transferring electrons, the carriers of quantum information, over several micrometres on a quantum chip. Their "quantum bus" could be the key component to master the leap to millions of qubits. Quantum computers have the potential to vastly exceed the capabilities of conventional computers for certain tasks. But there is still a long way to go before they can help to solve real-world problems. Many applications require quantum processors with millions of quantum bits. Today's prototypes merely come up with a few of these compute units. At some point, the number of signal lines becomes a bottleneck. The lines take up too much space compared to the size of the tiny qubits. And a quantum chip cannot have millions of inputs and outputs -- a modern classical chip only contains about 2000 of these. The overall goal of researchers is to integrate parts of the control electronics directly on the chip. The approach is based on so-called semiconductor spin qubits made of silicon and germanium. This type of qubit is comparatively tiny. The manufacturing processes largely match those of conventional silicon processors. This is considered to be advantageous when it comes to realising very many qubits. But first, some fundamental barriers have to be overcome. "The natural entanglement that is caused by the proximity of the particles alone is limited to a very small range, about 100 nanometres. To couple the qubits, they currently have to be placed very close to each other. There is simply no space for additional control electronics that we would like to install there," says a researcher Schreiber. To set the qubits apart, the JARA Institute for Quantum Information (IQI) came up with the idea of a quantum shuttle. This special component should help to exchange quantum information between the qubits over greater distances. An important step has now been achieved by Lars Schreiber and his team. They succeeded in transporting an electron 5000 times over a distance of 560 nanometres without any significant errors. This corresponds to a distance of 2.8 millimetres. One essential improvement: the electrons are driven by means of four simple control signals, which -- in contrast to previous approaches -- do not become more complex over longer distances. This is important because otherwise extensive control electronics would be required, which would take up too much space -- or could not be integrated on the chip at all. This achievement is based on a new way of transporting electrons. "Until now, people have tried to steer the electrons specifically around individual disturbances on their path. Or they created a series of so-called quantum dots and let the electrons hop from one of these dots to another. Both approaches require precise signal adjustment, which results in too complex control electronics," explains Lars Schreiber. "In contrast, we generate a potential wave on which the electrons simply surf over various sources of interference. A few control signals are sufficient for such a uniform wave; four sinusoidal pulses are all it takes." As a next step, the physicists now want to show that the qubit information encoded in the electron spin is not lost during transportation. Theoretical calculations have already shown that this is possible in silicon in certain speed ranges. The quantum bus thus paves the way to a scalable quantum computer architecture that can also serve as a basis for several million qubits.

Source https://www.sciencedaily.com/releases/2022/09/220922103140.htm

Mechanical Engineering

3. Converting 3D-printed polymer into a 100-times stronger, ductile hybrid carbon microlattice material

Developing a lightweight material that is both strong and highly ductile has been regarded as a long-desired goal in the field of structural materials, but these properties are generally mutually exclusive. Researchers at City University of Hong Kong (CityU) recently discovered a low-cost, direct method to turn commonly used 3D printable polymers into lightweight, ultra-tough, biocompatible hybrid carbon microlattices, which can be in any shape or size, and are 100 times stronger than the original polymers. The research team believes that this innovative approach can be used to create sophisticated 3D parts with tailored mechanical properties for a wide range of applications, including coronary stents and bio-implants. Metamaterials are materials engineered to have properties that are not found in naturally occurring materials. 3D architected metamaterials, such as microlattices, combine the benefits of lightweight structural design principles with the intrinsic properties of their constituent materials. Making these microlattices often requires advanced fabrication technologies, such as additive manufacturing (commonly referred to as 3D printing), but the range of materials available for 3D printing is still fairly limited. So far, the most effective approach for increasing the strength of these 3D printable polymer lattices is pyrolysis, a thermal treatment that transforms the entire polymers into ultra-strong carbon. However, this process deprives the original polymer lattice of almost all its deformability and produces an extremely brittle material, like glass. Other methods to increase the strength of the polymers also typically result in compromising their ductility. The team led by Professor Lu found a "magic-like" condition in the pyrolysis of the 3D-printed photopolymer microlattices, which resulted in a 100-fold increase in strength and doubled the ductility of the original material. They discovered that by carefully controlling the heating rate, temperature, duration and gas environment, it is possible to simultaneously enhance the stiffness, strength and ductility of a 3D-printed polymer microlattice drastically in a single step. Through various characterization techniques, the team found that simultaneous improvement in strength and ductility is possible only when the polymeric chains are "partially carbonized" by slow heating, where incomplete conversion of the polymer chains to pyrolytic carbon occurs, producing a hybrid material in which both loosely cross-linked polymer chains and carbon fragments synergistically coexist. The carbon fragments serve as reinforcing agents that strengthen the material, while the polymer chains restrict the fracture of the composite. The ratio of polymer to carbon fragments is also crucial to obtaining optimal strength and ductility. If there are too many carbon fragments, the material becomes brittle, and if there are too few, the material lacks strength. During the experiments, the team successfully created an optimally carbonized polymer lattice that was over 100 times stronger and over two times more ductile than the original polymer lattice. The research team also found that these "hybrid carbon" microlattices showed improved biocompatibility compared to the original polymer. Through cytotoxicity and cell behaviour monitoring experiments, they proved that the cells cultured on the hybrid carbon microlattices were more viable than cells seeded on the polymer microlattices. The enhanced biocompatibility of the hybrid-carbon lattices implies that the benefits of partial carbonization may go beyond enhancement in mechanical performance and potentially improve other functionalities as well. "Our work provides a low-cost, simple and scalable route for making lightweight, strong and ductile mechanical metamaterials with virtually any geometry," said Professor Lu. He envisions that the newly invented approach can be applied to other types of functional polymers, and that the geometrical flexibility of these architected hybrid-carbon metamaterials will allow their mechanical properties to be tailored for a wide range of applications, such as biomedical implants, mechanically robust scaffolds for micro-robots, energy harvesting and storage devices.

Source https://www.sciencedaily.com/releases/2022/09/220907133200.htm

Chemical Engineering

4. Simple method destroys dangerous 'forever chemicals,' making water safe

If you're despairing at recent reports that Earth's water sources have been thoroughly infested with hazardous human-made chemicals called PFAS that can last for thousands of years, making even rainwater unsafe to drink, there's a spot of good news. Chemists at UCLA and Northwestern University have developed a simple way to break down almost a dozen types of these nearly indestructible "forever chemicals" at relatively low temperatures with no harmful byproducts. The researchers show that in water heated to just 176 to 248 degrees Fahrenheit, common, inexpensive solvents and reagents severed molecular bonds in PFAS that are among the strongest known and initiated a chemical reaction that "gradually nibbled away at the molecule" until it was gone, said UCLA distinguished research professor and co-corresponding author Kendall Houk. The simple technology, the comparatively low temperatures and the lack of harmful byproducts mean there is no limit to how much water can be processed at once, Houk added. The technology could eventually make it easier for water treatment plants to remove PFAS from drinking water. Per- and polyfluoroalkyl substances -- PFAS for short -- are a class of around 12,000 synthetic chemicals that have been used since the 1940s in nonstick cookware, waterproof makeup, shampoos, electronics, food packaging and countless other products. They contain a bond between carbon and fluorine atoms that nothing in nature can break. When these chemicals leach into the environment through manufacturing or everyday product use, they become part of the Earth's water cycle. Over the past 70 years, PFAS have contaminated virtually every drop of water on the planet, and their strong carbon-fluorine bond allows them to pass through most water treatment systems completely unharmed. They can accumulate in the tissues of people and animals over time and cause harm in ways that scientists are just beginning to understand. Certain cancers and thyroid diseases, for example, are associated with PFAS. For these reasons, finding ways to remove PFAS from water has become particularly urgent. Scientists are experimenting with many remediation technologies, but most of them require extremely high temperatures, special chemicals or ultraviolet light and sometimes produce byproducts that are also harmful and require additional steps to remove. Northwestern chemistry professor William Dichtel and his team noticed that while PFAS molecules contain a long "tail" of stubborn carbon-fluorine bonds, their "head" group often contains charged oxygen atoms, which react strongly with other molecules. Dichtel's team built a chemical guillotine by heating the PFAS in water with dimethyl sulfoxide, also known as DMSO, and sodium hydroxide, or lye, which lopped off the head and left behind an exposed, reactive tail. "That triggered all these reactions, and it started spitting out fluorine atoms from these compounds to form fluoride, which is the safest form of fluorine," Dichtel said. "Although carbon-fluorine bonds are super-strong, that charged head group is the Achilles' heel."

But the experiments revealed another surprise: The molecules didn't seem to be falling apart the way conventional wisdom said they should. The researchers had expected the PFAS molecules would disintegrate one carbon atom at a time, but researchers ran computer simulations that showed two or three carbon molecules peeled off the molecules simultaneously, just as they had observed experimentally. The simulations also showed the only byproducts should be fluoride -- often added to drinking water to prevent tooth decay -- carbon dioxide and formic acid, which is not harmful. Dichtel confirmed these predicted byproducts in further experiments. The current work degraded 10 types of perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl ether carboxylic acids (PFECAs), including perfluorooctanoic acid (PFOA). The researchers believe their method will work for most PFAS that contain carboxylic acids and hope it will help identify weak spots in other classes of PFAS. They hope these encouraging results will lead to further research that tests methods for eradicating the thousands of other types of PFAS.

Source https://www.sciencedaily.com/releases/2022/08/220818163721.htm

Electrical Engineering

5. **Cobalt-free cathode for lithium-ion batteries**

Researchers at the University of California, Irvine and four national laboratories have devised a way to make lithium-ion battery cathodes without using cobalt, a mineral plagued by price volatility and geopolitical complications. The scientists describe how they overcame thermal and chemical-mechanical instabilities of cathodes composed substantially of nickel -- a common substitute for cobalt -- by mixing in several other metallic elements. "Through a technique we refer to as 'high-entropy doping,' we were able to successfully fabricate a cobalt-free layered cathode with extremely high heat tolerance and stability over repeated charge and discharge cycles," said corresponding author Huolin Xin, UCI professor of physics & astronomy. "This achievement resolves long-standing safety and stability concerns around high-nickel battery materials, paving the way for broad-based commercial applications." Cobalt is one of the most significant supply chain risks threatening widespread adoption of electric cars, trucks and other electronic devices requiring batteries, according to the researchers. However, nickel-based cathodes come with their own problems, such as poor heat tolerance, which can lead to oxidization of battery materials, thermal runaway and even explosion. Although high-nickel cathodes accommodate larger capacities, volume strain from repeated expansion and contraction can result in poor stability and safety concerns. The researchers sought to address these issues through compositionally complex high-entropy doping using HE-LMNO, an amalgamation of transition metals magnesium, titanium, manganese, molybdenum and niobium in the structure's interior, with a subset of these minerals used on its surface and interface with other battery materials. Xin and his colleagues employed an array of synchrotron X-ray diffraction, transmission electron microscopy and 3D nanotomography instruments to determine that their zero-cobalt cathode exhibited an unprecedented volumetric change of zero during repeated use. The highly stable structure is capable of withstanding more than 1,000 cycles and high temperatures, which makes it comparable to cathodes with much lower nickel content. "The combination of the different methods at NSLS II beamlines enabled the discovery of a trapping effect of oxygen vacancies and defects inside the material, which effectively prevents the crack formation in the HE-LMNO secondary particle, making this structure extremely stable during cycling," said co-author Mingyuan Ge, a scientist at NSLS-II.Added Xin: "Using these advanced tools, we were able to observe the dramatically increased thermal stability and zero-volumetric-change characteristics of the cathode, and we've been able to demonstrate extraordinarily improved capacity retention and cycle life. This research could set the stage for the development of an energy-dense alternative to existing batteries." He said the work represents a step toward achieving the dual goal of spurring the proliferation of clean transportation and energy storage while addressing environmental justice issues around the extraction of minerals used in batteries.

Source https://www.sciencedaily.com/releases/2022/09/220921210059.htm

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6. Smart microrobots walk autonomously with electronic 'brains'

Cornell University researchers have installed electronic "brains" on solar-powered robots that are 100 to 250 micrometers in size -- smaller than an ant's head -- so that they can walk autonomously without being externally controlled. While Cornell researchers and others have previously developed microscopic machines that can crawl, swim, walk and fold themselves up, there were always "strings" attached; to generate motion, wires were used to provide electrical current or laser beams had to be focused directly onto specific locations on the robots. "Before, we literally had to manipulate these 'strings' in order to get any kind of response from the robot," said Itai Cohen, professor of physics. "But now that we have these brains on board, it's like taking the strings off the marionette. It's like when Pinocchio gains consciousness." The innovation sets the stage for a new generation of microscopic devices that can track bacteria, sniff out chemicals, destroy pollutants, conduct microsurgery and scrub the plaque out of arteries. The "brain" in the new robots is a complementary metal-oxide-semiconductor (CMOS) clock circuit that contains a thousand transistors, plus an array of diodes, resistors and capacitors. The integrated CMOS circuit generates a signal that produces a series of phase-shifted square wave frequencies that in turn set the gait of the robot. The robot legs are platinum-based actuators. Both the circuit and the legs are powered by photovoltaics. "Eventually, the ability to communicate a command will allow us to give the robot instructions, and the internal brain will figure out how to carry them out," researcher Cohen said. "Then we're having a conversation with the robot. The robot might tell us something about its environment, and then we might react by telling it, 'OK, go over there and try to suss out what's happening.'" The new robots are approximately 10,000 times smaller than macroscale robots that feature onboard CMOS electronics, and they can walk at speeds faster than 10 micrometers per second. The fabrication process that Reynolds designed, basically customizing foundry-built electronics, has resulted in a platform that can enable other researchers to outfit microscopic robots with their own apps -- from chemical detectors to photovoltaic "eyes" that help robots navigate by sensing changes in light. "What this lets you imagine is really complex, highly functional microscopic robots that have a high degree of programmability, integrated with not only actuators, but also sensors," another researcher Reynolds said. "We're excited about the applications in medicine -- something that could move around in tissue and identify good cells and kill bad cells -- and in environmental remediation, like if you had a robot that knew how to break down pollutants or sense a dangerous chemical and get rid of it."

Source https://www.sciencedaily.com/releases/2022/09/220921210054.htm

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Aerospace Engineering

7. ISRO successfully tests hybrid motor, eyes new propulsion system for rockets

The Indian Space Research Organisation (ISRO) has recently successfully tested a hybrid motor, potentially paving the way for a new propulsion system for the forthcoming launch vehicles. The 30 kN hybrid motor tested at ISRO Propulsion Complex (IPRC) at Mahendragiri in Tamil Nadu is scalable and stackable, the Bengaluru-headquartered space agency said. Unlike solid-solid or liquid-liquid combinations, a hybrid motor uses solid fuel and liquid oxidiser, it was noted. "Today's (Tuesday's) September 20, 2022 test of a flight equivalent 30 kN hybrid motor demonstrated ignition and sustained combustion for the intended duration of 15 seconds. The motor performance was satisfactory", an ISRO statement said. The use of liquids facilitates throttling, and the control over the flow rate of LOX enables the re-start capability, it was explained. While both HTPB and LOX are green, LOX is safer to handle, ISRO noted. "The hybrid motor tested today (Tuesday) is scalable and stackable, potentially paving the way for a new propulsion system for the forthcoming launch vehicles", it said.

Source https://timesofindia.indiatimes.com/india/isro-successfully-tests-hybrid-motor-eyes-new-propulsion-system-for-rockets/articleshowprint/94348026.cms

8. A swarm of 3D printing drones for construction and repair

An international research team led by drone expert Mirko Kovac of Empa and Imperial College London has taken bees as a model to develop a swarm of cooperative, 3D-printing drones. Under human control, these flying robots work as a team to print 3D materials for building or repairing structures while flying. 3D printing is gaining momentum in the construction industry. Both on-site and in the factory, static and mobile robots print materials for use in construction projects, such as steel and concrete structures. A new approach to 3D printing -- led in its development by Imperial College London and Empa, the Swiss Federal Laboratories of Materials Science and Technology -- uses flying robots, known as drones, that use collective building methods inspired by natural builders like bees and wasps. The system, called Aerial Additive Manufacturing (Aerial-AM), involves a fleet of drones working together from a single blueprint. It consists of BuilDrones, which deposit materials during flight, and quality-controlling ScanDrones, which continually measure the BuilDrones' output and inform their next manufacturing steps. The researchers say that in contrast to alternative methods, in-flight 3D printing unlocks doors that will lead to on-site manufacturing and building in difficult-to-access or dangerous locations such as post-disaster relief construction and tall buildings or infrastructure. The research was Led by Professor Mirko Kovac of Imperial's Department of Aeronautics and Empa's Materials and Technology Center of Robotics. Professor Kovac said: "We've proved the concept that drones can work autonomously and in tandem to construct and repair buildings, at least in the lab. This scalable solution could help construction and repair in difficult-to-reach areas, like tall buildings." Aerial-AM uses both a 3D printing and path-planning framework so the drones can adapt to variations in geometry of the structure as a build progresses. The drones are fully autonomous in flight, but there is a human controller in the loop can monitor progress and intervene if necessary, based on the information provided by the drones. To test the concept, the researchers developed four cement-like mixtures for the drones to build with. Throughout the build, the drones assess the printed geometry in real time and adapt their behaviour to ensure they meet the build specifications, with manufacturing accuracy of five millimetres. The proof-of-concept prints included a 2.05-metre cylinder (72 layers) with a polyurethane-based foam material, and an 18-centimetre cylinder (28 layers) with a custom designed structural cement-like material. The technology offers future possibilities for building and repairing structures in unbounded, high or other hard-to-access locations. Next the researchers will work with construction companies to validate the solutions and provide repair and manufacturing capabilities. They believe the technology will provide significant cost savings and reduce access risks compared to traditional manual methods.

Source https://www.sciencedaily.com/releases/2022/09/220922103202.htm

Energy Engineering

9. Paving the way for large-scale, efficient organic solar cells with water treatment

Organic solar cells (OSCs) are attractive owing to their lightweight, flexibility, and high-power conversion efficiency. However, a lack of morphology control of the active layer makes it challenging to develop OSCs with large active areas. Now, researchers from Gwangju Institute of Science and Technology, Korea take things to the next level by using water treatment for morphology control in the fabrication of active layer thin films, improving the performance and stability of large-area OSCs.

Organic solar cells (OSCs), which use organic polymers to convert sunlight into electricity, have received considerable attention in recent times for their desirable properties as next-generation energy sources. These include lightweight, flexibility, scalability, and a high-power conversion efficiency (>19%). Currently, several strategies exist for enhancing the performance and stability of OSCs. However, a problem that lingers on is the difficulty of controlling the morphology of the active layer in OSCs when scaling up to large areas. This makes it challenging to obtain high-quality active layer thin films and, in turn, fine-tune the device efficiency. A team of researchers from the Gwangju Institute of Science and Technology, Korea set out to address this issue. In their work, they suggested a solution that appears rather counterintuitive at first glance: using water treatment to control the active layer morphology. "Water is known to hinder the performance of organic electronic devices, since it remains in the 'trap states' of the organic material, blocking the charge flow and degrading the device performance. However, we figured that using water rather than an organic solvent-based active solution as a medium of treatment method would enable necessary physical changes without causing chemical reactions," explains Professor Dong-Yu Kim, who headed the study. The researchers chose the polymers PTB7-Th and PM6 as donor materials and PC61BM and EH-IDTBR and Y6 as acceptor materials for the active layer. They noticed that inducing a vortex to mix the donor and acceptor materials in the active solution could lead to a well-mixed active solution, yet it was not enough on its own. The active solution was hydrophobic and, accordingly, the researchers decided to use deionized (DI) water and vortices to stir the solution. They let the donor and acceptor materials sit in chlorobenzene (host active solution) overnight, and then added DI water in the solution and stirred it, creating tiny vortices. Due to the hydrophobic nature of the solution, the water pushed on the donor and acceptor molecules, causing them to dissolve more finely into the solution. They then let the solution rest, which caused the water to separate from the solution. This water was then removed, and the water-treated active solution was used to prepare thin films of PTB7-Th: PC61BM (F, fullerene), PTB7-Th: EH-IDTBR (NF, fullerene), and PM6: Y6 (H-NF, high-efficiency non-fullerene). The researchers then examined the photovoltaic performance of these thin films in a slot-die-coated inverted OSC configuration and compared them with those for OSCs without water treatment. "We observed that the water-treated active solution led to a more uniform active layer thin films, which showed higher power conversion efficiencies compared to those not treated with water. Moreover, we fabricated large-area OSC modules with an active area of 10 cm2, which showed a conversion efficiency as high as 11.92% for water-treated H-NF films," highlights Prof Kim. Overall, this study provides a guideline for developing large-scale, efficient OSCs using a remarkably easy, economical, and eco-friendly method, which can open doors to their realization and commercialization.

Source https://www.sciencedaily.com/releases/2022/09/220915104650.htm

10. Wearable sensors styled into T-shirts and face masks

Imperial researchers have embedded new low-cost sensors that monitor breathing, heart rate, and ammonia into t-shirts and face masks. Potential applications range from monitoring exercise, sleep, and stress to diagnosing and monitoring disease through breath and vital signs. Spun from a new Imperial-developed cotton-based conductive thread called PECOTEX, the sensors cost little to manufacture. Just $0.15 produces a metre of thread to seamlessly integrate more than ten sensors into clothing, and PECOTEX is compatible with industry-standard computerised embroidery machines. First author of the research Fahad Alshabouna, PhD candidate at Imperial's Department of Bioengineering, said: "The flexible medium of clothing means our sensors have a wide range of applications. They're also relatively easy to produce which means we could scale up manufacturing and usher in a new generation of wearables in clothing." The research team embroidered the sensors into a face mask to monitor breathing, a t-shirt to monitor heart activity, and textiles to monitor gases like ammonia, a component of the breath that can be used to track liver and kidney function. The ammonia sensors were developed to test whether gas sensors could also be manufactured using embroidery. Fahad added: "We demonstrated applications in monitoring cardiac activity and breathing, and sensing gases. Future potential applications include diagnosing and monitoring disease and treatment, monitoring the body during exercise, sleep, and stress, and use in batteries, heaters, anti-static clothing." Wearable sensors, like those on smartwatches, let us continuously monitor our health and wellbeing non-invasively. Until now, however, there has been a lack of suitable conductive threads, which explains why wearable sensors seamlessly integrated into in clothing aren't yet widely available. Enter PECOTEX. Developed and spun into sensors by Imperial researchers, the material is machine washable, and is less breakable and more electrically conductive than commercially available silver-based conductive threads, meaning more layers can be added for to create complex types of sensor. Lead author Dr Firat Guder, also of the Department of Bioengineering, said: "PECOTEX is high-performing, strong, and adaptable to different needs. It's readily scalable, meaning we can produce large volumes inexpensively using both domestic and industrial computerised embroidery machines. "Our research opens up exciting possibilities for wearable sensors in everyday clothing. By monitoring breathing, heart rate, and gases, they can already be seamlessly integrated, and might even be able to help diagnose and monitor treatments of disease in the future." Next, the researchers will explore new application areas like energy storage, energy harvesting and biochemical sensing, as well as finding partners for commercialisation.

Source https://www.sciencedaily.com/releases/2022/09/220923121721.htm

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ENGINEERING INNOVATION IN INDIA

1. Indian Railways installs ISRO-developed RTIS system for real-time train tracking

Developed in collaboration with the Indian Space Research Organisation (ISRO), Real Time Train Information System (RTIS) is being installed on the trains for automatic acquisition of its "movement timing at the stations, including that of arrival and departure or run-through", the Ministry of Railways said. "They get automatically plotted on the control chart of those trains in the Control Office Application (COA) system," the Ministry added. According to the Ministry, RTIS gives mid-section updates with a periodicity of 30 seconds. The Train Control can track the location and speed of RTIS enabled trains more closely, without any manual intervention. The RTIS uses information from GSAT satellites that have GAGAN payloads for tracking the movement of trains and sends the information down to the Central Location Server (CLS) of Centre for Railway Information Systems (CRIS). The same information is passed on using enterprise service BUS in CRIS' data centre to the National Train Enquiry System (NTES). From there on, NTES feeds that information to all the public information dissemination systems be it websites, mobile apps, the 139 railway helpline number, or any other medium. "RTIS devices have been installed for 2,700 locomotives in 21 electric loco sheds. As part of Phase-II roll out, 6,000 more locomotives across 50 loco sheds shall be covered by utilising ISRO's Satcom hub," the Ministry said in a statement. "Currently, GPS feed from around 6,500 Locomotives (RTIS and REMMLOT) is being directly fed into the Control Office Application (COA). This has enabled automatic charting of trains and real time information flow to passengers through COA and NTES integration," the statement further read. Meanwhile, according to an ANI report, the newly launched Chatbot of Indian Railway Catering and Tourism Corporation Limited (IRCTC) is getting remarkable response from the train passengers. During the beta launch, over 1 billion people have used it, a senior official told ANI.

Source https://www.financialexpress.com/infrastructure/railways/indian-railways-installs-isro-developed-rtis-system-for-real-time-train-tracking-check-what-is-rtis-and-how-does-it-work/2691247/

2. IIT Jodhpur, Algo8 AI Collaborate to Make Oil Refining in Petroleum, Allied Industries More Efficient

IIT Jodhpur researchers has developed a model for control and schedule maintenance of heat exchanger networks to increase the efficiency of refineries.

The Indian Institute of Technology (IIT) Jodhpur has collaborated with Algo8 AI Private Limited to develop a data pipeline build-up and machine learning model for heat exchangers of oil and petroleum refineries. Professor Pradip Kumar Tewari, Head, Department of Chemical Engineering, and Dr Angan Sengupta, Assistant Professor, Department of Chemical Engineering and Affiliated Faculty in SAIDE, IIT Jodhpur, along with their research team of postgraduate students are providing consultation service for this project. Speaking about the problem statement of this project, Professor Pradip Kumar Tewari, Head, Department of Chemical Engineering, IIT Jodhpur, said, "Researchers at IIT Jodhpur are well capable of dealing with such a fundamental problem with its traditional chemical engineering knowledge base amalgamated with modern modelling and computation-based know-how in the field of chemical engineering."

Source https://www.ndtv.com/education/iit-jodhpur-algo8-ai-collaborate-make-oil-refining-in-petroleum-allied-industries-more-efficient

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Note: *Fellows are requested to forward their achievements/achievements of their organziation to be featured under the heading "Engineering Innovation in India".*

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