INDIAN NATIONAL ACADEMY OF ENGINEERING

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From the Editor's Desk

Science refines thinking

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Purnendu Ghosh
Chief Editor of Publications

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"The whole of science is nothing more than a refinement of everyday thinking," said Albert Einstein. Science has affected us in different ways, and has made profound changes in the way we think, the way our social organizations and political systems function, and the way our environment is controlled. It is believed, science has made society more organic; "in the sense of increasing the interdependence of its various parts." Science has brought critical changes in the quality of our life. Engineers and scientists have given us a wonderful vocabulary, but we need to be careful, as John Polanyi writes, "It is impossible to produce a vocabulary with which one can say only nice things." The responsibilities of an engineer and a scientist, therefore, collectively as well as individually, need an update and made socially relevant from time to time.

Scientists discover patterns, using logic and imagination, to establish a fact. They often succeed, and often fail. The objective they pursue often deviates from the conventional ideas. They want to establish a direct correspondence between their objectives and outcomes. Often, this doesn't happen. Even a highly coherent scientific theory may yield results that are far from the truth. In spite of careful observation and deductive reasoning, scientists may arrive at wrong conclusions.

The synthesis between scientific spirit and humanism is necessary to refine thinking. Some science humanists believe that science is a way of thinking that is much more significant than a body of knowledge. The science humanist Carl Sagan believed in maintaining an essential balance between the two attitudes: an openness to new ideas, no matter how counter-intuitive they may be, and the most ruthlessly sceptical scrutiny of all ideas, old and new. Scientists have also been branded as the "destroyers of the awe and wonder of nature." Sagan's counter argument is "scientists do not seek to impose their needs and wants on Nature, but instead humbly interrogate nature and take seriously what they find."

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INAE Annual Convention 2016 at Space Applications Centre, Ahmedabad

This year, the INAE Annual Convention is being held at Space Applications Centre (SAC), Ahmedabad on Dec 8-10, 2016 which will be preceded by Governing Council meeting on 7th Dec 2016. Mr. Tapan Misra, FNAE and Director, SAC has kindly consented to host the event. The format of the INAE Annual Convention has been amended to include the following additional activities besides the normal proceedings held each year.

(a) Inaugural Session wherein an eminent engineering luminary is invited as the Chief Guest.
(b) An Industry Session wherein presentations by practicing engineers from the industry to include CEOs of Start-ups has been planned.
(c) Sideline meetings of the INAE Forums on "Engineering Interventions for Disaster Mitigation" and "Indian Landscape of Advanced Structural Materials"
(d) Brainstorming Session for suggesting the "Way Forward" for INAE.
(e) Two Plenary talks to include one on an engineering project implemented and other on a general topic of engineering interest.
(f) A cultural Programme showcasing the cultural heritage of Gujarat followed by the Annual Dinner.

An invitation to all INAE Fellows and Young Associates to participate in the Annual Convention has been sent. All those who have still not confirmed their participation may kindly do so at the earliest, but not later than Nov 10, 2016, so as to make administrative arrangements accordingly. A Block Programme of the INAE Annual Convention is enclosed .....for information.

INAE-DST Meeting on "Clean Coal Technologies"

INAE had been requested by Department of Science and Technology (DST), Govt. of India to give suitable inputs for a brief status report on clean coal technologies, like gaps, short term plans, long terms plans, etc and suggest a roadmap for taking up research which can lead to development of clean coal technologies in the country. In this regard, INAE in association with DST had organized a Round Table on "Clean Coal Technologies in India: Current Status, Demands and Aspirations – Pathways to Achievements" on June 10, 2016. Eminent experts from academia, R&D and Industry working in the area of clean coal technologies participated in the workshop.

During the final session of the workshop, it was decided to prepare a comprehensive report highlighting the specific areas, gaps if any, and further actions needed to bridge the gaps, including the identification of research areas where further funding can be considered. The specialists were also identified to prepare the report and the inputs have since been obtained from the authors on the topics identified during the subject Round Table.

The meeting to finalize the comprehensive report containing inputs from all the authors on the selected topics in the area of Clean Coal Technologies identified earlier; will be held on Oct 26, 2016 at New Delhi. It is also proposed to finalize the list of research topics in each of the areas identified in the comprehensive report by the authors; for onward submission to DST, as required. The meeting will be chaired by Dr. Baldev Raj, Director, NIAS.

Research Journal -INAE Letters

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

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

Creation of Data for INAE Expert Pool

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

website on Expert Pool has been appreciated by all the agencies and the data would be used by them in identifying suitable domain experts and to involve the experts in their activities.

Opening of Facebook and Twitter Accounts by INAE

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

International Conferences/Seminars being organized by IITs/other Institutions

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

Honours and Awards

1.	Prof P Somasundaran, FNAE, La von Duddleson Krumb Professor, Columbia University; Director of Langmuir Centre for Colloids & Interfaces, and Director of the National Science Foundation Industry/University Cooperative Research Centre was conferred the Lifetime Achievement Award by International Engineering Congress during a Banquet in Quebec City in Canada on Sept 14, 2016.
2.	Cmde R B Verma (Retd), FNAE Advisor, Advisor, Industrial Consultancy and Sponsored Research, Indian Institute of Technology Madras, Chennai was awarded the Life Time Achievement Award by Society of Automotive Engineers (SAE) International, in February 2016

News of Fellows

1.	Dr PA Lakshminarayanan, FNAE, Chief Technical Officer, Simpson and Co. Ltd., Chennai has recently published a paper on "A New Two Cylinder Diesel Engine Family for Off-road in Naturally Aspirated and Turbocharged Intercooled Versions" in SAE International about the new family of six engines developed by his team at Simpsons over six years with fifteen applications off-road.
2	Prof R P Mohanty, FNAE, Senior Advisor - ICFAI Group has been selected for conferment of Honorary degree of Doctor of Science by Sambalpur University, Odisha which will be conferred in their Diamond Jubilee Convocation on 7th November, 2016.

PROGRAMME

ANNUAL CONVENTION – DECEMBER 8-9, 2016

DECEMBER 8

0930 – 1000 hrs. - **Registration**

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

- Welcome by Mr. Tapan Misra, Director, Space Applications Centre.
- Presidential Address by Dr. BN Suresh, President, INAE .
- Address by Chief Guest from Industry
- Address by Guest of Honour, Shri AS Kiran Kumar, Chairman, Space Commission, Chairman, ISRO and Secretary, Department of Space.
- Release of Report on "Engineering Interventions Necessary for Achieving 175 GW of Renewable Power by 2022"
- Vote of Thanks.

1100 – 1130 hrs. - **TEA**

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

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

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

1330– 1430 hrs. - **LUNCH**

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

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

1700 – 1730 hrs. - **HIGH TEA WITH AWARD WINNERS**

1730-1900 hrs. - **Award Function**

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

1900 – 1915 hrs **BREAK**

1915 – 2030 hrs - **Cultural Programme**

2030 – 2130 hrs - **INAE Fellows Annual Dinner**

DECEMBER 9

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

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

1100 – 1130 hrs. - **TEA**

1130 –1300 hrs. **Plenary Talks**

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

1300– 1330 hrs. - **LUNCH**

1330 – 1430 hrs. **Industry Session**

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

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

Parallel Session-1

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

Parallel Session-2

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

1700– 1730 hrs. - **TEA**

New Delhi 4th International Conference on "Engineering & Technology, Computer, Basic & Applied Sciences" (ECBA- 2016) on Nov14-15, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=173416

International Conference on Innovative Research in Computer Science, E-Learning, Information & Communication Technology (CSIT– 2016) on Nov 19, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=176358

International Conference on Recent Trends in Advanced Engineering on Nov 25-26, 2016 at Bengaluru
http://www.conferencealerts.com/show-event?id=177576

ENGINEERS –PRE-EMINENT IN SOCIETY

SS Chakraborty

Engineers. Who are they? Are they a special breed? How did they become engineers? Who do they serve? Who, if anyone, do they guide? What is their purpose? What is their status in society?

These questions have been asked many times and have been answered too. Yet, there indeed is a need to revisit them, particularly as the context keeps changing as befitting a growing society.

Let us define engineering as opposed to science. A wise man once said, "The scientist seeks to understand what is; the engineer seeks to create what never was." Let this be our starting premise – engineers are creators. That is, engineering is undergirded by creativity. Sure, engineers are not in the same mold as Picasso, Salvador Dali or Raja Ravi Varma. But, the same may be said in reverse too.

At the same time engineers are practical scientists. They would complete a job at the earliest practical opportunity and not wait indefinitely to meet an asymptotic line.

Engineering creativity does not allow unlimited freedom to explore – after all, in its analytical avatar, engineering is a reincarnation of science – but the canvas is large, indeed very large for an engineer's creativity to shine through and it is ever expanding.

This is the Kieler Horn Folding Bridge, conceived by an architect and realized by an engineer. The bridge has become a tourist attraction, pride of the locality and a tribute to the ingenuity of engineering. About every hour or so "the middle of the jetty ... swivels, pulls, flips, and folds..." to let ships pass under and to let pedestrians cross as required. Engineering is alive!

Engineers fulfil the dreams, ideas and imaginations of people, including engineers, to effect in reality. Consider Eiffel Tower, designed and built in 1989 by engineers of a company owned by engineer Alexandre Gustave Eiffel; in the face of constant adverse criticism by groups of architects of that time in France. Creation it is; and also the most visited monument in the world today.

Consider also the 1450ftWillis Tower, earlier known as Sears Tower, structurally designed by Fazlur Rahman Khan, pioneering the concept of "Bundled Tube" structure which revolutionized the building of skyscrapers. The concept has been used in many tall structures since then including the BurjKhalifa in Dubai)

There are countless examples of such innovations, ideas and concepts translated into reality for society to benefit for centuries. If one understands the background of various engineering creations one sees, it would not be possible to go unimpressed with the creativity disguised in them, be it the Jawaharlal Nehru Stadium in Delhi, Bandra-Worli Sea Link in Mumbai, the successful space missions of Chandrayaan and Mangalyaan, the cranes that dot the skyscape in skyscraping building sites, the huge machines that operate in open-cast mines, the nuclear containment vessels and the control systems that govern the operation of the facility.

So, to answer the opening questions, engineers are rational and analytical artists, creating masterpieces that excite people while serving them and also expanding the scope of their profession. They indeed are a special breed for the simple reason they have defined what appears to be an oxymoron – rational artist.

How did engineers become engineers? Through education, of course. Engineering education, besides developing the mindset of rational, step-by-step thinking, must also invoke and nurture the creative spirit of the students. Is this happening in India? Perhaps not. We are into a particular mode of engineering education that appears not to be too keen in promoting the creative art of engineering. Why is this a point of argument in this discussion? The answer comes straight out of how we have defined an engineer, a rational artist, imbued with creativity.

Yes, we must focus on implementing projects, but as engineers we must also involve ourselves at the stages of conceptualization and planning so that a project can carry a holistic character. If you read about how the Mars Lander mission of NASA came about it becomes evident that comprehensive involvement of engineers in this mission from the first step contributed immensely in its astounding success.

Unfortunately the engineers are seldom inducted in the planning process with the result that, more often than not, the concept gets modified during implementation culminating in something at variance with the original perception.

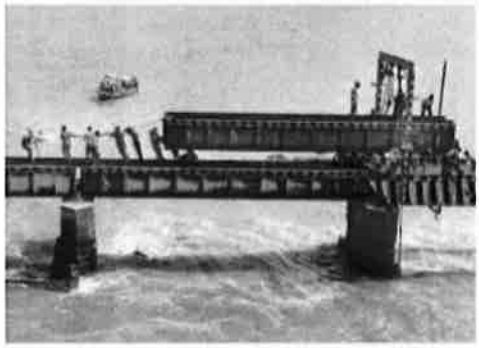
Coming down to the real world in this regard, to a large extent how the Second Vivekananda Bridge metamorphosed from a government department driven project into one that became the curtain raiser for PPP mode of execution is a lesson in how an engineering

entrepreneur and engineer got involved and led the efforts in this transformation. A dream, of the people, came true.

If engineers learn how to conceptualize the product from the bare specifics offered at the induction of a project, they cannot but be ensured of its success. Engineers must be taught to lead the society by being involved in the process, from beginning to end. Here is where our engineering education maybe lacking. As we would see later, this might even be the causal factor in the perceived relegation of engineers in the eyes of society.

Engineers serve the society. That is an insipid statement, as it is expected that every citizen would serve society in whatever capacity, even as he serves himself. This is almost a direct take from Adam Smith who said that the baker does not bake bread for feeding the hungry but for earning his livelihood. But, in the context of engineering, it goes much deeper than that.

Engineers, because of the specialized training they get, are expected to guide the society even as they serve the community of which they are a part. It was 1964 and nature created havoc – washed away sections of the rail link between Rameswaram and the mainland across Palk Strait. Engineers were called in. The link was restored in 46 days even as the project was scheduled for 6 months. This is leadership and commitment by engineers to society and the country at large.



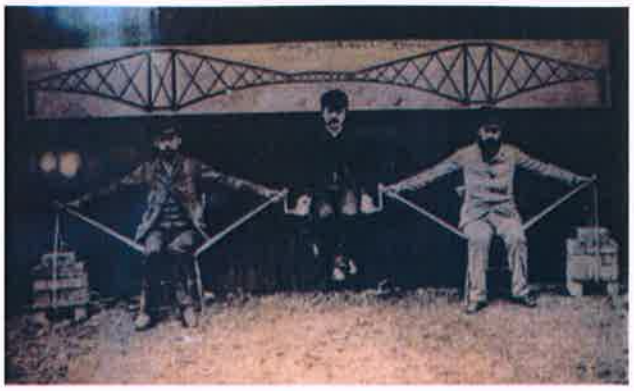
Let us also look at what happened in the aftermath of the Bhuj earthquake. The codes that engineers use in engineering became very stringent, demanding details that were not in the cards up until then. These measures ought to be looked at in two different ways.

One, the profession implicitly admitted that the then extant codes were not up to scratch. Continuous improvement was perceived as basic duty of the engineer; the demand arising from within the profession itself. The code was further rationalized and strengthened.

Two, there were murmurs from the construction industry that such tightening of the codes may make scrupulous engineers vulnerable at the hands of a few unscrupulous ones; a valid concern and this must be taken as a clarion call for the profession to wake up the sleeping community.

But this wakeup call must be clarity personified. It is this lack of clarity, in the language the general public can understand, that led to six seismologists being incarcerated (though all but one was subsequently exonerated) in the famous L'Aquila earthquake case in Italy.

Coming to the language in which engineers should speak to the society, there really can be no better example than how the engineer convinced the public body of the feasibility and safety of the iconic Firth of Forth Bridge. Just two images will make the case and rest it too.



We must see the above in terms of serving as well as guiding the society.

But, engineers are also humans, after all. As human qualities, good and bad, permeate through all strata of society there are instances of engineers falling prey to the songs of sirens, like greed, jealousy, unethical gaming of the system and others. A professional body, in one of the developed countries, once received a letter for interpreting a particular clause of a code. Later it became clear that the interpretation offered was in the interest of a company with high-level ties to the professional body and against that of a smaller company – a classic case of conflict of interest and the Supreme Court of the country ordered the professional body to pay reparations.

Obviously the above incidence is not to the credit of the profession. Yet, it does illuminate that practicing professionalism demands that one wades carefully through the waters. If nothing else, this incident proved that engineers are part and parcel of society. It is perhaps impossible to claim that the above is a one-off incidence. But what we must remember is the Engineering ethics; yes, this must be one of the founding pillars of what defines an engineer.

Engineers serve multiple purposes in the cause of society. First, they promote rational analysis imbued with practicality. Second, they cater to the demands of society. Third, engineers look forward, always thinking, "How to do this better?" This could have an effect on the society, if only the society had been prepared to receive the message. This process of preparation is also a mode of serving society. Fourth, engineers protect society, many times after the fact but sometimes proactively. Addressing climate change and developmental concerns, say, conceptualizing, designing, constructing and operating a solar chimney.

To err is human and engineers are not an exception. But, the profession has internal checks and balances that take it forward. The benefits of admitting one's mistakes is a big lesson engineers impart to society. Of course, overarching all of the above, engineers create. This role goes unacknowledged for the most part.

It is time to wonder about the status of engineers in society. Sometimes in the past, engineers were admired across all levels of society. It is not the case now. What caused this transformation?

Perhaps engineers contributed to it. Take the case of Krishna Raja Sagara (KRS) across the River Kaveri. We celebrate it as the creation of Sir Mokshagundam Visvesvaraya.

That word creation! The dam was "created". Now, who "created" the Bandra-Worli Sea Link? We do not think of it but take it for granted.

No, it was merely designed and built. No one associates "creation" with a bridge these days. Note the change in the perspective. In "creation", he who creates, engineers, is put on a pedestal. In "designing and constructing", the engineer becomes a mere worker. In our hierarchical society, does anyone care about workers? Engineers do the job and take home the salary. There is no "vision" associated in this endeavor.

To get society to glorify engineering, engineers have to become visionaries. They should avoid being risk-averse, within the constraint of time, space and economy, yet follow the professional standards. This ties in well with the idea that engineers are creators but unlike artists, they are constrained by their profession and perceived duty to society. The unwanted, undeserved relegation of engineers in society hierarchy must be righted

immediately. How to do it is a major topic in its own right and we would do better to avoid discussing it here.

To conclude, engineers are creators. They become so by the dint of their efforts–education, professional practice, and research – institutionally supported. They serve the society in myriad of ways. Impart pride to the society through their eye-popping accomplishments. And, they lead the society too, showing what can be achieved. The dual mandate, to be a worker and be a leader too, is a knife-edge balancing act. Engineers have to perfect their skills in this.

Engineers must work towards projecting themselves to society in two distinct ways – a productive member of society while leading it.

They are, thus, part of, yet distinct and pre-eminent.

Evolving ideas of teaching and research in engineering institutions during my journey in academics over five decades

B Yegnanarayana

1. Background

Being in the academic field for over 5 decades, I felt that I should write my views on teaching and research, especially in engineering institutions, based on my experience. Frankly, I have been collecting my thoughts on this subject over the past several years, and I do express them in limited forums, like in my general talks I give while addressing the students and faculty in academic institutions. I am very hesitant to put my thoughts in writing, as it may invite criticism because many of the ideas go against the currently held views by most educational planners and administrators. Finally, I ventured to write this, mainly expressing my personal views, based on the changes I have been observing in the education field during my 5 decades of teaching and research in engineering institutions. Please note that these are my personal views, many of which may not be backed up by solid facts and figures.

I would like to emphasize that this article is only about teaching and research, and not about coaching and training. I feel that coaching and coaching institutions are meant to prepare for competition, like in games, and have limited or short term goal. On the other hand, training is for preparing someone to acquire a skill, mostly for living with that skill. But teaching is meant to prepare students for learning how to learn. Research is meant mostly for developing creative abilities, especially to generate new ideas. Hence all these four are for different groups of people with different aims, and there is no conflict or overlap among their roles.

I am expressing these views in the backdrop of the following developments in recent times. We often hear these days that we should have over 1000 universities, producing 10000 PhDs per year, and having online classes with over 100000 students per class. We seem to excessively focus on the number of PhD to be produced, and making the PhD degree mandatory for promotion even in ordinary teaching colleges. Since research is measured in terms of number of publications, citations and awards, people seem to be working towards them, instead of doing any serious research. The proliferation of journals and conferences is testimony to this. Also, there is a growing belief expressed by many planners and educators that teachers can/should be replaced by technology. In such an environment, it is difficult to convince even the administrators of teaching and research institutes that the real meaning of teaching and research is different from what is happening in their places.

In this article I try to give one view of teaching and of research, which many may not agree in public, but accept it as correct in private. This write-up also reflects my bias acquired over the past 50 years of my teaching engineering students and also doing research in engineering institutions. In the process of this writing I try to clarify the five terms

relevant to this topic, namely, education, learning, knowledge, teaching and research.

Let me assert that I am a teacher by choice, and not by chance or accident, and hence I kept away from administrative roles as far as possible throughout my career. Based on my teaching experience (this is my 50th year of teaching), I feel that teaching involves production, perception and learning of patterns. Here teaching refers to teaching human beings by human beings, and hence the link to the biological neural network (BNN), i.e., the human brain. The main feature of the BNN is pattern processing, which includes the multimodal nature of pattern perception and learning. The production part of teaching is the ability of the teacher to produce multimodal data of a concept, to convey the pattern to the listener. Note that the pattern exists in a high dimension space of the data, and it cannot be compressed. The listeners can then perceive the pattern in the multimodal data and attempt to learn by developing associations or links to the patterns already developed in the listeners' minds. The ability of capturing the pattern in the data and associating it with other patterns in the brain is the process of learning. The teacher enables this to happen by generating appropriate multimodal data. Thus significant effort on the part of the teacher is in generating the multimodal data for a given concept. The multimodal data here means the gestures through vocal, hand, facial and the general body movements, besides the other data, if any, such as slides, audio and video demonstrations.

The multimodal data need not be unique or precise. Actually being precise (in the form of definition or unique description) is not a virtue in teaching. Some variation helps the listeners to learn better. The pattern information in the generated multimodal data is captured by the multimodal nature of pattern perception and learning of the biological system, i.e., BNN. Interestingly, teaching is also a continuous learning process for the teacher, as while expressing the concept through multimodal data, the teacher comes up with better ways of producing the data for the same concept, based on his own feedback and the feedback from the listeners' reactions, in the form of gestures, questions and comments. A good teacher is one who can produce such multimodal data to convey the concept through the pattern information in the data. Thus there could be good teachers or bad teachers (initially in their career), depending on the effort they put in. But generally, there are no good or bad students. We will also see below that teaching almost becomes a prerequisite for research.

Coming to research, it is common to mention that there is a methodology for research, and that it can be described or discussed in a structured manner, as though it has some beginning and ending. But in my opinion, research has no methodology or structure to describe. Research is a process and not a product. It is for the process a person is credited with a degree such as Doctor of Philosophy. The thesis examiners, while recommending the award of the degree, usually mention that the candidate has demonstrated his/her ability to carry out independent research. In research, the candidate should demonstrate their ability to see the problems clearly, and in the process of finding solutions, they may generate more problems than solutions.

Research involves understanding and building links among the components of the problem, rather than breaking up the problem into sub problems, leading to destroying the problem itself. One can appreciate what constitutes great research, by recalling great research ideas, such as Maxwell's equations, Sabine's formula, Shanon's information theory, Kalman filtering, to name a few in my domain of research. Ultimately, both research and teaching are passionate endeavours, and cannot be done by mere training or coaching. In this context, let us recall how ideas of teaching and research have evolved

over the past several decades. First, we will consider teaching.

2. Evolution of Teaching

In 1950s, some of the teachers in schools and colleges used to teach with passion. For example, it was language and arts classes that were more interesting than science and maths classes. The teacher teaching Shakespeare drama used to enact the event in the play in the beginning of the class, and then explain the English part of it. Likewise, teacher of Telugu poetry used to start the class with pleasant rhythmical recitation of the lesson, and then explain the meaning of the poem, along with several linked stories. I was fortunate to have such teachers in my college. Where are those teachers now? In 1960s teachers try to prepare the lesson with a desire to communicate the concept to the students. Textbooks were very carefully and concisely written. Not many questions or worked out examples were available in the books. Also, the teachers did not focus much on working out examples in the classes. Since copies of the books were limited, students used to write notes carefully in the classes and supplement with additional reading material in the libraries. For some subjects, lab experiments supplemented the classes. There were fewer exams. Students were credited for asking good questions. There were not many questions in the books, nor there were many question-banks. Mostly, the annual exams were used to assess the candidates. The dynamic range of the performance of the students is indicated by the range of marks the class gets, mostly in the range of 0 to 70% marks. In fact getting more than 70% was rare and exceptional. Thus the students know where they actually stand in the class.

In 1970s, use of overhead projection of transparency sheets started for class room lectures. Then the teachers were busy preparing the transparency sheets, and thus in the class they were not developing the concepts with illustrations. The students tend to look at the projected material rather than watching the multimodal display of information by the teacher through his gestures, voice modulation, with on the fly illustrations and stories. Question-banks for various subjects were coming up, with even answers to some of the questions. This helped the teacher to set question papers easily. It also helped the students to follow the pattern of questions that the teachers would ask. Thus the students slowly lost their ability to make and ask their own questions. The teachers also are slowly trying to adopt to the pattern of the questions in the question-banks, instead of trying to create questions based on the interaction with the students in the class.

Slowly the credit system with electives also produced distance between teacher and students in 1980s. Teachers definitely lost touch with students, as they meet/see the students from different disciplines and departments assemble for the class hour and then disappear. With the wide variety of the background of the students, the teacher is forced to dilute the contents of the course, and also lost time for providing the background of the prerequisite courses for significant part of the course. Giving assignments and solutions to problems, and also continuous evaluation through frequent tests and exams, resulted in transferring the load of evaluation to teaching assistants, thus further reducing the contact between teacher and students. Also, the problems, questions, answers, etc. all of them were tailored to enable the teaching assistants to evaluate the students. In 1990s the curriculum, the course contents, teaching and evaluation became more structured towards grading the students. The concept of learning is either ignored or diluted. The craze for better grades/marks due to competition among students has increased, whichhas increased even the distance among the students, and the distance with the teacher still further.

In the decade of 2000, drastic changes took place in education system, with computers becoming easily available, and communication through internet making the distant people apparently closer, and the closer people distant. Many more worked out examples, with easily implementable software packages, have changed the way books are written. While it helped a few motivated students with better access of these resources, the general attitude of the students is to get some how good grades/marks and a good job after that. There is less exposure to concepts in the classes any more. And the teachers and the system also are tuning their activities to cater for the needs of the students rather than educating them. For example, the question papers are of objective type to tick an answer among the alternatives.

The average grades of students are thus jacked up, with almost making 70% or equivalent as a poor mark/grade, 90% is average and 99% or more as desired/required. Even the institutions were evaluated based on how many students get such high grades. Thus while it used to be difficult to get 70% or more up to 1970s, it turned out that it is now difficult to get less than 70% or equivalent grade. With far lesser effort on the part of the student, they are rated high, almost making it appear that all the students are in a small dynamic range at the top. Because of this, grades/marks cannot be used for discriminating the abilities of students any more. In addition, there are too many activities focussed around internet and mobile, with no time for concentration on learning. Learning is reduced to mere acquisition of skills/data, which was provided outside the classroom without teachers, like video lectures, online courses, etc.

The decade starting with 2010, with the availability of smart phones and internet connectivity, has changed the meaning of student and studies. There is very little attention in classes. Most lectures are reduced to mere projection of slides, with the intention of pumping the students with data. With online courses and mass learning classes, the purpose of education became giving certificates, diplomas and degrees. The focus is only on tools and their usage, which is more like a technician job. The emphasis on explaining and understanding concepts is gone, and the basic subjects are replaced with skill-oriented subjects. Throughout this evolution, instead of exploiting the technology for improving the quality of education, we seem to let the technology drive the education system. Thus education is viewed more from business point of view, and several business models have evolved for imparting education. There is very little learning in its true sense any more, at all levels starting from the primary level to the university level. We have almost reduced the role of a teacher to that of a facilitator/mentor, rather than that of teaching and learning.

3. **Evolution of Research**

Let us review how the concept of research is evolving over time. In 1950s, there was hardly any serious talk about research. Very few people opted to work for research degrees. The few that were doing research were doing on their own interest, without expecting any return out of it. There was also very little support for doing research. Most people were happy with a basic degree to make some living after that. In 1960s, people, especially in the teaching profession at elite institutions, were doing research mainly for professional growth. At that time, many lecturers were working for PhD under the guidance of senior faculty, mainly at IISc and IITs. With very little access to computing and experimental facilities, they were able to do excellent research, as reflected in the publications in peer reviewed international journals. It is interesting to know that most of them did not know much about those journals, except by their access through libraries, usually 3 months or more after their release.

Availability of computing and experimental resources has improved significantly in 1970s, leading to computer-oriented research, but still most of the research was experimental or theoretical. This was the period when money for research was being made available at some of the leading institutions through sponsored research projects, mainly from government agencies. The computer-oriented research took a big leap in 1980s, with the availability of powerful (at that time) mainframecomputers at several leading institutions and laboratories in the country. In that euphoria, less of practical/experimental work was being carried out, as every one was busy doing scientific programming for research.

In 1990s, the meaning of research is getting dwarfed. As many computer-oriented gadgets being made available, and doing work with computers becoming easier, all problems were oriented towards computer modelling and simulation. Also, it helped in thinking of bigger problems with large number of parameters for modelling and optimization. Setting up experimental facilities for verification of results and thinking of such problems reduced drastically. During that period, even writing abilities were also affected due to extensive use of word processing tools. Most research was aimed at collecting more data for analysis with computers.

In the decade of 2000, the experimental work in most engineering disciplines has practically vanished. Almost all laboratories were filled with computers, with prominent display of monitors and keyboards everywhere. It was almost difficult to find out to which engineering discipline a lab belongs to. Many of the research scholars did not have a feel of the values of the parameters in the real experimental facilities. On the other hand, for senior researchers, the computational facilities augmented their engineering skills acquired through experimentation. The 2000 decade also has seen the vanishing of writing skills among students completely, as most research scholars spend their time in typing and editing, as dictated by the tools such as Microsoft word.

As senior faculty, we were helplessly looking at how the students are busy spending most of their time in formatting, tuning the figures and tables for better display of the document, but at the cost of understanding the contents of their display. Research scholars spend all the time in front of a monitor, pretending as though they are doing serious research, whereas they are only searching all the time aimlessly. Due to fast switching, they also lost the ability to focus on any topic or equation or figure. Writing papers is reduced to writing reports with casual English and poor organization of the thought process in their minds. It is also obvious during this and the previous decade, that the aim was on getting more papers published. There is also proliferation of journals and conferences to meet this demand. It became a fashion/necessity that the conference deadlines decide on what to submit, and then quickly manage to write a few lines based on some simulation work. It is no more that you have 'something to convey' and hence write a paper. It has become a routine exercise to write something and submit. Some organizations also insist on journal papers for faculty promotions. To meet this demand, many online journals have come up, making a mockery of research and its reporting. With emphasis on numbers and quantity, plagiarism has crept in, and organizations proudly announce that they have acquired plagiarism detection software to check such happenings. What a tragedy we have ended up with in the domain of research.

We almost lost control on research in the decade beginning 2010. Proliferation of the so called institutions of higher learning, research universities, etc. with emphasis on number of PhDs and research papers, rather than quality, working towards awards and recognition, data-oriented computer based

research, all of this contributed to confusion on what is research, and how to do it. It appears that, instead of understanding research, and then doing it out of passion for it, it is routinely claimed that whatever any one is doing is research. Even the high school students or 1st year undergraduate students talk of doing research, without understanding the meaning of research. I hate to think of what is in store for us in the coming years.

It is unfortunate that the tremendous potential of the developments of communication and information technologies is grossly misused in teaching and research. Otherwise, these developments should have significantly enriched our learning and creative abilities through good teaching and research, and also should have produced excellent teachers and researchers. Unfortunately, we have misused the technology, by making teaching and research as business opportunities. Many start-ups and coaching centres (most of them have no idea of education) approach us with proposals that they can help us with tools/gadgets to improve our teaching and research abilities.

4. **Current Practices Affecting Teaching and Research**

4.1 Teaching

- Absence of good teachers: Students are not getting the high dimension pattern for absorbing the concepts.
- Projecting ppt slides: Missing or destroying the pattern information.
- Text books: Poorly written with too many distractions like unnecessary colours, worked out examples, programs and exercises.
- Worked out examples: No motivation for the student to think about a solution.
- Readymade programs: Students do not develop the logic for solving a problem.
- Learning from examples: Not thinking about concepts and logical reasoning.
- Learning by doing: Without understanding principles
- Too many distractions: Fast changing data, with no time to absorb the pattern, if any.
- Too much emphasis on applications without learning concepts.
- Too much of technology and gadgets.
- Continuous evaluation with too much focus on assignments and exams in a semester: This results in short-time remembrance, and forgetting them soon after the semester.
- Objective type questions: Working from the answer, and not solving the problem.
- Grading system with high grade points or marks: Misplaced emphasis and poor judgement of the standard of a student, thus conveying false impression of accomplishment, talent and abilities.
- Competition, rather than cooperation: Education is not a zero-sum game.
- Too many competitive exams with focus on problems and their solutions.
- Acquiring skills during school/college: This is a wrong notion, as education is meant for learning how to learn, and not how to acquire a skill. Skill development institutions are different, like polytechnics.
- Too high exceptions of salaries and positions, without really deserving.
- Too much of societal and parental pressure on the students: Education is viewed as a business opportunity, and not as a process for learning.
- Summer and winter internships: Doctors do these after their studies, whereas engineers attempt to do it during their studies, without consolidating the subjects they studied.

4.2 Research

- Searching the web: Directionless most of the time

- Misplaced emphasis on research without passion
- Misplaced emphasis on degrees
- Poor writing abilities due to typing, cut and paste process, editing tools, etc.
- Poor reading abilities due to lack of concentration, and also due to poor quality of books
- Starting (catching them) young, especially for research is wrong, as it takes time to understand what research means
- Talking about research without knowing what it is
- Whatever one does is being projected as research, instead of doing real research
- Proliferation of research universities, without any significant research in them

4.3 Management Perspective

- Looking at education as a business opportunity, and applying management principles, like for any zero-sum game.
- Aiming at products (students) for IT (information Technology) ready, skill equipped, technology ready, etc, is not appropriate for education.
- Should technology drive education, or education drive technology?
- Generalizing from a few successful/failure cases, as often used as case studies in a business model, is not appropriate for education.
- Goal of education: Need to improve the average for the prosperity of a nation, and not aiming at excellence in some specific items and individuals.

5. Some Points for Good Teaching and Research

5.1 Points for Good Teaching

- Teaching refers to teaching human beings endowed with biological neural networks (BNN) for pattern processing
- Being precise is not a virtue in teaching: Learning takes place only when there is some vagueness, as precision involves only listing of facts.
- Multimodal nature of pattern perception and learning by BNN requires that teaching should cater for it.
- Teaching is a continuous learning process.
- Learning is the ability to absorb the pattern in high dimensional space, and hence the teacher needs to create the pattern in high dimensional space.
- Learning by doing works only when the process of learning is understood.
- Reducing the problem to sub problems or divide and conquer paradigm is not relevant most of the time in teaching, as it destroys the pattern information in the problem (as in .ppt slides)
- Difference between teaching (making the students learn the constraints hence acquire knowledge) and coaching (involving taking students along a specified path). (Compare construction of sentences naturally and those following strict rules of grammar, or compare printed characters and written characters) - Disadvantage of continuous evaluation/grading: Likely to disrupt long term retention.
- Teaching is a prerequisite for research, as it enables creating/generating multimodal patterns of a concept. (Recall the missing art of storey telling in teaching these days)

5.2 Points for Good Research

- Research is a process and not a product: PhD is a recognition for the process.
- Research has no methodology, as the underlying process is unstructured.
- Research is not only finding solutions to a problem, but ability to see the issues in the problems, and this in turn may generate more problems than solutions.
- Research is a passionate endeavour.
- Research involves, reading, writing and sharing ideas with

colleagues for comments and criticism.
- Research is a cooperative effort, and not competitive. IPR (Intellectual Property Rights) issues need to be addressed in this context, and not in a commercial context.
- Research involves developing and building links among patterns, and not breaking them up.
- Research needs concentrated effort without too many distractions.
- Mere search inhibits research.
- Discipline in writing is essential, and hence the need to focus on writing for journals instead of for conferences.
- Research guide is like a coach for a game, as his goal is to act as a critique, and not as a promoter of the effort.

6. Summary, Conclusions and Recommendations

6.1 Summary

In this article I tried to explain the evolution of teaching and research over decades, and in the process we can get to understand the meaning of the terms like coaching, training, teaching and research. Coaching refers to taking the student along the path of the solution, like taking someone to a destination by hand-holding. Obviously the student will not know how to go by himself later when the need arises. Training refers to making the student to acquire a skill, so that he can use that skill repeatedly in a job. It does not involve any creativity or learning. Teaching refers to the process of generating a multimodal and multidimensional data to convey a pattern to the listener, which he/she can easily absorb due to pattern processing ability of the human mind.

Research involves ability to create new patterns based on the patterns already acquired through learning. It is important that people understand the meaning of learning, knowledge and education. Learning involves perceiving patters in high dimensional data, and developing associations with the existing patterns in human mind. Knowledge refers to understanding the constraints from examples, so that the legal variations are captured within those constraints. Finally, education means learning how to learn, which is made possible mostly by teachers.

6.2 Conclusions

Despite the fact that over the past few decades we are continuously making changes in the education system at various levels, there is hardly any positive comment on the standards of the education system, especially in the teaching and research domains. It is fashionable to compare us and our system with systems in other countries, especially with China and USA, in terms of papers published, number of PhDs, awards, percentage gross domestic product (GDP) spent on research, etc. But it is unlikely that even with increased investment to higher levels, we can make any significant progress, as it appears that we are moving in the wrong direction. In my opinion, teaching and research are local and culture-specific. Borrowing or copying other models will not work. A country's progress should be measured in terms of (a) increase in the average level of education (b) increase in number of good teachers who will make it possible, and (c) research will follow automatically. The effects of current fall in standards of teaching and research may take us to such low levels very soon, that we may reach a point of no return in about 5 to 10 years, if corrective mechanisms are not put in place now.

6.3 Recommendations

- Make classroom teaching more purposeful and interesting, rather than dispensing with classroom and student-teacher interaction. For this we definitely need more teachers.

- Emphasize writing and reading, not typing, editing and searching.
- Make an effort to teach in a way that students learn.
- Learning is an effort to understand legal variations of an idea or concept, like construction of sentences with deviations from grammar/syntax.
- Think about problems, not solutions. Write your thoughts, express them and discuss.
- Solutions to problems are always worked out in mind first, and the gadgets are useful mostly to verify those solutions in mind. Otherwise, gadgets can reduce the degrees of freedom in our thought process.
- Search only with a purpose in mind. Otherwise, searching can distract and disturb our pattern formation and hence research abilities.
- Restore the missing art of storey telling in engineering presentations and teaching over time.
- Recall great research ideas, processes and results.

7. Final Remarks

Currently the tremendous progress in technology and communications is being grossly misused, thus reducing our abilities to do good teaching and research. This needs to be corrected, and hence this article. Note that good teaching and research evolve with good environment and practices. They cannot be created by a procedure or a rule. I strongly believe that a country's progress should be measured in terms of number of teachers, especially good teachers, it produces, and not in terms of number of PhDs, or number of papers published, or number of award winners, or number of universities, etc. This is because, each teacher can brighten the lives of 30 or more students in a class, some of them may become teachers a few years later. Note that teaching is not a zero-sum game, as in the case of business. Here there is only gain, and no loss whatsoever. This is the beauty of teaching and research.

I would like to end this write-up by recalling (in a lighter vein) my observation on how books in engineering have evolved over the past six decades since my student days. In 50s, books were written, carefully explaining the concepts clearly, with hardly any questions at the end of the chapters, at least in some good books. The idea probably was to make the readers and students think on how to make a question or how to ask a question to the teacher in a class. Thus the books in any subject also were about 300 pages or so. In 60s, many books have questions at the end of the chapters, and there were also books with mainly problems on a particular subject, like Parker Smith's "Problems in Electrical Engineering". Thus the students and teachers started looking at those problems for both exercises as well as for question papers for examinations.

In 70s, books started giving not only problems at the end of chapters, but also answers to the problems. This helped the students to work towards getting the answer to the question, rather than understanding the question and attempting to solve the problem. In 80s, the books started giving worked out examples within each chapter, enabling students and teachers to focus more on those things rather than the text part describing the concepts. The sizes of the text books also became bulky, as most books are over 600 pages or more. In 90s, books started giving programs for some problems within the text itself, making it even easier for the student to simply run the programs and look at the results. This made the students skip reading even the solutions of the problems carefully, leave alone reading the text, which habit has almost vanished among many students.

In the decade of 2000 something very significant has happened in engineering studies. Books like "All in ONE" with only problems and solutions for many subjects in each engineering branch have appeared in the market. Both students and teachers

focussed mostly on these books mainly from examination point of view. This has resulted in the erosion of class room teaching of concepts completely, as the engineering education system geared up only for conducting exams and giving grades to students. It appears as though whatever the students learn is from the example problems and solutions given in such books.

At this stage in the middle of the 2010 decade, it is difficult for me to guess what is in store for engineering education by the end of this decade. From this development, I could bring an analogy of human learning vs machine learning. One of the elusive goals of scientists and engineers is to make machines learn like human beings, so that machines can be made to perform tasks similar to those by human beings. But we seem to have achieved the goal of making machines and human beings similar in their learning abilities, by making human beings also learn from examples, just as we make machines learn from examples in machine learning. Thus we made both of them nearly same by making humans do the way the machines do, rather than the other way. Can we call this as a great achievement in education over the decades?

Civil Engineering

1. World's Tallest Wood Building Completed: 18 Storeys

The mass wood structure and façade has been completed for UBC's Brock Commons student residence -- the world's tallest wood building at 18 storeys (53 metres, about 174 feet) -- four months ahead of schedule, showcasing the advantages of building with wood. The structure was completed less than 70 days after the prefabricated components were first delivered to the site. Construction will now focus on interior elements, with completion expected in early May 2017 -- 18 per cent (or four months) faster than a typical project. The building is expected to welcome more than 400 students in September 2017. Brock Commons is the first mass wood, steel and concrete hybrid project taller than 14 storeys in the world. The building has a concrete podium and two concrete cores, with 17 storeys of cross-laminated-timber floors supported on glue-laminated wood columns. The cladding for the façade is made with 70 per cent wood fibre. "Brock Commons is living proof that advanced wood products are a terrific material to build with and support efficient assembly. It also showcases new applications for B.C. lumber, leading to new job opportunities in B.C.'s forest industry," said Steve Thomson, Minister of Forests, Lands and Natural Resource Operations. Other wood structure buildings on UBC's Vancouver campus include the AMS Student Nest, the Engineering Student Centre, the Centre for Interactive Research on Sustainability, the Bioenergy Research and Demonstration Facility, and the Earth Sciences building. "Wood is increasingly recognized as an important, innovative and safe building material choice. This new tall wood building reflects UBC's leadership in sustainable construction and our commitment to providing our students with more on-campus housing," said UBC President Santa J. Ono. As a "living laboratory," Brock Commons will also be a source of learning through interdisciplinary research and educational projects undertaken by UBC faculty, staff and students. "Taller wood buildings offer tremendous economic and environmental benefits. Wood is a sustainable and versatile building material that stores, rather than emits, carbon dioxide. By using wood, the impact is a reduction of 2,432 metric tonnes of carbon dioxide compared to other construction materials, the equivalent of taking around 500 cars off the road for a year. The building is targeting LEED Gold certification, a rating system that promotes environmental responsibility for building owners and operators. It will exceed required fire ratings and standard seismic safety requirements.

Source https://www.sciencedaily.com/releases/2016/09/160930145847.htm

Computer Engineering and Information Technology

2. No GPS, no Problem: Next-Generation Navigation

Simulation results for a unmanned drone flying over downtown Los Angeles showing the true trajectory (red line), from GPS only (yellow line), and GPS aided with cellular signals (blue line).

A team of researchers at the University of California, Riverside has developed a highly reliable and accurate navigation system that exploits existing environmental signals such as cellular and Wi-Fi, rather than the Global Positioning System (GPS). The technology can be used as a standalone alternative to GPS, or complement current GPS-based systems to enable highly reliable, consistent, and tamper-proof navigation. The technology could be used to develop navigation systems that meet the stringent requirements of fully autonomous vehicles, such as driverless cars and unmanned drones. Led by Zak Kassas, assistant professor of electrical and computer engineering in UCR's Bourns College of Engineering, the team presented its research at the 2016 Institute of Navigation Global Navigation Satellite System Conference in September. Most navigation systems in cars and portable electronics use the space-based Global Navigation Satellite System (GNSS), which includes the U.S. system GPS, Russian system GLONASS, European system Galileo, and Chinese system Beidou. For precision technologies, such as aerospace and missiles, navigation systems typically combine GPS with a high-quality on-board Inertial Navigation System (INS), which delivers a high level of short-term accuracy but eventually drifts when it loses touch with external signals. Despite advances in this technology, current GPS/INS systems will not meet the demands of future autonomous vehicles for several reasons: First, GPS signals alone are extremely weak and unusable in certain environments like deep canyons; second, GPS signals are susceptible to intentional and unintentional jamming and interference; and third, civilian GPS signals are unencrypted, unauthenticated, and specified in publicly available documents, making them spoofable (i.e., hackable). Current trends in autonomous vehicle navigation systems therefore rely not only on GPS/INS, but a suite of other sensor-based technologies such as cameras, lasers, and sonar. "By adding more and more sensors, researchers preparing autonomous vehicle navigation systems for the inevitable scenario that GPS signals become unavailable. We took a different approach, which is to exploit signals that are already out there in the environment," Kassas said. Instead of adding more internal sensors, Kassas and his team in UCR's Autonomous Systems Perception, Intelligence, and Navigation (ASPIN) Laboratory have been developing autonomous vehicles that could tap into the hundreds of signals around us at any point in time, like cellular, radio, television, Wi-Fi, and other satellite signals. The system can be used by itself, or, more likely, to supplement INS data in the event that GPS fails. The team's end-to-end research approach includes theoretical analysis of SOPs in the environment, building specialized software-defined radios (SDRs) that will extract relevant timing and positioning information from SOPs, developing practical navigation algorithms, and finally testing the system on ground vehicles and unmanned drones. "Autonomous vehicles will inevitably result in a socio-cultural revolution. My team is addressing the challenges associated with realizing practical, cost-effective, and trustworthy autonomous vehicles. Our overarching goal is to get these vehicles to operate with no human-in-the loop for prolonged periods of time, performing missions such as search, rescue, surveillance, mapping, farming, firefighting, package delivery, and transportation," Kassas said.

Source https://www.sciencedaily.com/releases/2016/10/161013150039.htm

Mechanical Engineering

3. Achieving Ultra-Low Friction without Oil Additives

Researchers at Georgia Institute of Technology have developed a new process for treating metal surfaces that has the potential to improve efficiency in piston engines and a range of other equipment.The method improves the ability of metal surfaces to bond with oil, significantly reducing friction without special oil additives. "About 50 percent of the mechanical energy losses in an internal combustion engine result from piston assembly friction. So if we can reduce the friction, we can save energy and reduce fuel and oil consumption," said Michael Varenberg, an assistant professor in Georgia Tech's George W. Woodruff School of Mechanical Engineering. In the study, the researchers at Georgia Tech and Technion -- Israel Institute of Technology tested treating the surface of cast iron blocks by blasting it with mixture of copper sulfide and aluminum oxide. The shot peening modified the surface chemically that changed how oil molecules bonded with the metal and led to a superior surface lubricity. "We want oil molecules to be connected strongly to the surface. Traditionally this connection is created by putting additives in the oil," Varenberg said. "In this specific case, we shot peen the surface with a blend of alumina and copper sulfide particles. Making the surface more active chemically by deforming it allows for replacement reaction to form iron sulfide on top of the iron. And iron sulfides are known for very strong bonds with oil molecules." Oil is the primary tool used to reduce the friction that occurs when two surfaces slide in contact. The new surface treatment results in an ultra-low friction coefficient of about 0.01 in a base oil environment, which is about 10 times less than a friction coefficient obtained on a reference untreated surface, the researchers reported. "The reported result surpasses the performance of the best current commercial oils and is similar to the performance of lubricants formulated with tungsten disulfide-based nanoparticles, but critically, our process does not use any expensive nanostructured media," Varenberg said. The method for reducing surface friction is flexible and similar results can be achieved using a variety of processes other than shot peening, such as lapping, honing, burnishing, laser shock peening, the researchers suggest. That would make the process even easier to adapt to a range of uses and industries. The researchers plan to continue to examine that fundamental functional principles and physicochemical mechanisms that caused the treatment to be so successful. "This straightforward, scalable pathway to ultra-low friction opens new horizons for surface engineering, and it could significantly reduce energy losses on an industrial scale," Varenberg said. "Moreover, our finding may result in a paradigm shift in the art of lubrication and initiate a whole new direction in surface science and engineering due to the generality of the idea and a broad range of potential applications."

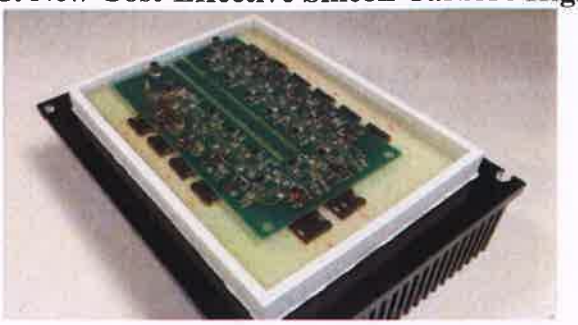
Source https://www.sciencedaily.com/releases/2016/10/161011161912.htm

4. Organic Semiconducting Polymers can Harvest Sunlight to Split CO_2 into Alcohol Fuels

Chemists at The University of Texas at Arlington have been the first to demonstrate that an organic semiconductor polymer called polyaniline is a promising photocathode material for the conversion of carbon dioxide into alcohol fuels without the need for a co-catalyst."This opens up a new field of research into new applications for inexpensive, readily available organic semiconducting polymers within solar fuel cells," said principal researcher Krishnan Rajeshwar, UTA distinguished professor of chemistry and biochemistry and co-Director of UTA's Center for Renewable Energy, Science & Technology. "These organic semiconducting polymers also demonstrate several technical advantages, including that they do not need a co-catalyst to sustain the conversion to alcohol products and the conversion can take place at lower temperatures and use less energy, which would further reduce costs," Rajeshwar added. Rajeshwar and co-workers recently published their findings in The Royal Society of Chemistry journal *ChemComm* as "Polyaniline films photoelectrochemically reduce CO_2 to alcohols." In this proof-of-concept study, the researchers provide insights into the unique behaviour of polyaniline obtained from photoelectrochemical measurements and adsorption studies, together with spectroscopic data. They also compared the behaviour of several conducting polymers. The stationary currents recorded after two hours during testing suggests that the polyaniline layer maintained its photoelectrochemical efficacy for the studied time period. While in the gas phase, only hydrogen was detected, but potential fuels such as methanol and ethanol were both detected in the solution for carbon dioxide-saturated samples. "Apart from these technical qualities, as a polymer, polyaniline can also be easily made into fabrics and films that adapt to roofs or curved surfaces to create the large surface areas needed for photoelectrochemical reduction, eliminating the need for expensive and dangerous solar concentrators," Rajeshwar added. Frederick MacDonnell, chair of UTA's Department of Chemistry and Biochemistry, said "Dr. Rajeshwar's ongoing leadership in research around new materials for solar fuel generation is vital in a world where we all recognize the need to reduce the impact of carbon dioxide emissions," MacDonnell said. "Finding an inexpensive, readily-available photocathode material could open up new options to create cheaper, more energy-effective solar fuel cells."

Source https://www.sciencedaily.com/releases/2016/10/161006121112.htm

5. New Cost-Effective Silicon Carbide High Voltage Switch Created

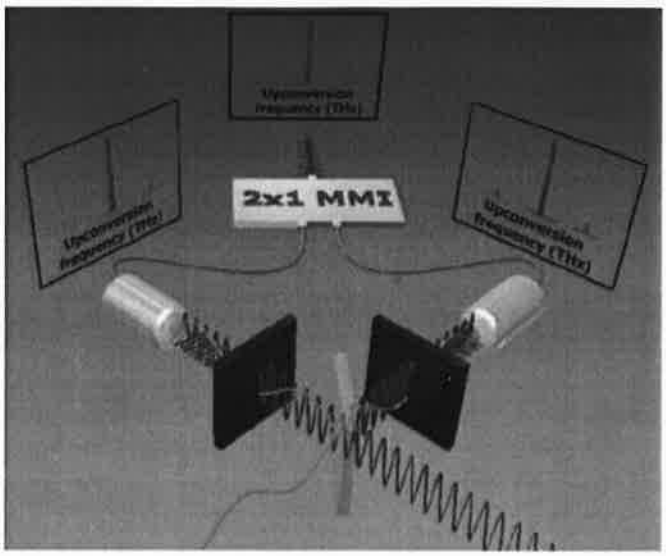


A new NC State high-power switch has the potential to work more efficiently and cost less than conventional solutions.

Researchers at North Carolina State University have created a high voltage and high frequency silicon carbide (SiC) power switch that could cost much less than similarly rated SiC power switches. The findings could lead to early applications in the power industry, especially in power converters like medium voltage drives, solid state transformers and high voltage transmissions and circuit breakers. Wide bandgap semiconductors, such as SiC, show tremendous potential for use in medium- and high-voltage power devices because of their capability to work more efficiently at higher voltages. Currently though, their high cost impedes their widespread adoption over the prevailing workhorse and industry standard -- insulated-gate bipolar transistors (IGBT) made from silicon -- which generally work well but incur large energy losses when they are turned on and off. The new SiC power switch, however, could cost approximately one-half the estimated cost of conventional high voltage SiC solutions, say Alex Huang and Xiaoqing Song, researchers at NC State's FREEDM Systems Center, a National Science Foundation-funded engineering research centre. Besides the lower cost, the high-power switch maintains the SiC device's high efficiency and high switching speed characteristics. In other words, it doesn't lose as much energy when it is turned on or off. The power switch, called the FREEDM Super-Cascode, combines 12 smaller SiC power devices in series to reach a power rating of 15 kilovolts (kV) and 40 amps (A). It requires only one gate signal to turn it on and off, making it simple to implement and less complicated than IGBT series connection-based solutions. The power switch is also able to operate over a wide range of temperatures and frequencies due to its proficiency in heat dissipation, a critical factor in power devices. "Today, there is no high voltage SiC device commercially available at voltage higher than 1.7 kV," said Huang, Progress Energy Distinguished Professor and the founding director of the FREEDM Systems Center. "The FREEDM Super-Cascode solution paves the way for power switches to be developed in large quantities with breakdown voltages from 2.4 kV to 15 kV."

Source https://www.sciencedaily.com/releases/2016/10/161006120901.htm

6. Key Component for Wireless Communication with Terahertz Frequencies



The THz wave (green) and the laser light (red) are both split in half by the beam splitter (grey plane), providing the necessary phase shift of the waves. The laser light is mixed with THz radiation in special crystals (brown planes), and subsequently two sidebands (blue waves) are generated. Both laser light modulations are then coupled in the grey cylinders in optic fiber (tan wires) and combined in the multimode interference structure (white MMI plane). The result is that one sideband extinguishes and that the intensity of the other sideband is maximized, solving the problem of THz signal distortion in the optic fiber network.

An ultrahigh speed, wireless communication network using THz instead of GHz frequencies is now one step closer. Researchers at Radboud University's FELIX Laboratory have shown that it is possible to effectively transmit signal waves with THz frequencies through the existing fibre optic network. HD television, big data, the internet of things and social media have considerably increased the data rate of our wireless communication network, and continue to do so. An obvious way to facilitate this network growth is to use terahertz frequencies (THz, 1012 Hertz) with high-speed data rates of up to 100 Gbit/s. Current wireless data communication systems operate at an average speed of 100Mbi/s using microwave frequencies around one gigahertz (GHz, 109 Hertz). For instance: GPS systems work with 1,3 GHz frequencies, wifi with 2,4 and 5 GHz, and your microwave with 2,45 GHz. In the search for free frequencies, the unexplored THz area is of great interest. For wireless THz surfing on the Internet, it is necessary to connect THz wireless stations to the worldwide fibre optic network. However, existing microwave techniques do not operate at THz frequencies. "THz is a difficult frequency region, because it is both electronic and optic at the same time," FELIX researcher explains. "It is too low for normal optics, and too high for standard electronics." Moreover, THz signal waves in the fibre optic network are scrambled, because standard modulation of laser light generates two sidebands (colours) that interfere with one another. Optical Single Side Band (OSSB) is a method to prevent this scrambling of information by selectively extinguishing one sideband. Scientists at Radboud University's FELIX Laboratory developed an OSSB modulator that enables wireless THz waves to be transmitted unperturbed through the fibre network. A researcher explains: "With a specially designed beam splitter that splits both the THz waves and the infrared laser light in half, one of the two sidebands is reduced by a factor of over sixty, while the other sideband's intensity increases significantly." The special modulator does not contain any moving parts or colour filters, and operates over an ultra-wide bandwidth from 0.3 to 1 THz. The THz OSSB modulator is a by-product of the research by TeraOptronics on the THz laser FLARE (Free-electron Laser for Advanced spectroscopy and high-Resolution Experiments) at Radboud University. "The apparatus to determine the colour of FLARE's laser light was exactly what was needed to observe THz OSSB," a researcher explains. As THz signals in the air are strongly absorbed by water vapour, wireless THz communication will mostly be used for relatively short distances. In addition: "Our THz OSSB modulator allows us to use the existing fiber optic network. Ultra HD and Virtual Reality images can be received or transmitted wirelessly through a THz link, just like the petabytes of data in research institutes and hospitals." Another researcher said: "This publication is a proof of principle. To actually use the technique requires a couple of additional steps, for instance scaling down the design for microfabrication and improvements in efficiency. Our hope is that this idea will be further developed by the industry."

Source https://www.sciencedaily.com/releases/2016/10/161004085303.htm

7. ISRO Successfully Launches Eight Satellites

PSLV C35's launch of the SCATSAT 1 satellite. Photo: ISRO

The Indian Space Research Organization (ISRO) had announced that its Polar Satellite Launch Vehicle (PSLV), in its 37th flight (PSLV C35) has successfully launched eight satellites in a landmark mission on September 26, 2016. This was a highly significant mission for ISRO as it marked the first time its PSLV launch vehicle had launched payloads into two different orbits. ISRO has launched the 371 kg SCATSAT 1 for weather related studies and seven co-passenger satellites into polar Sun Synchronous Orbit (SSO). The co-passenger satellites are ALSAT 1B, ALSAT 2B, ALSAT 1N from Algeria, NLS 19 from Canada and Pathfinder-1 from USA as well as two satellites PRATHAM from **IIT Bombay** and PISAT from **PES University**, Bengaluru. SCATSAT 1 was placed into a 720 km Polar SSO whereas the two Universities/Academic Institute satellites and the five foreign satellites will be placed into a 670 km polar orbit. PSLV C35 was launched from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on September 26, 2016. India's workhorse PSLV, for the first time, injected eight different satellites, including weather satellite SCATSAT-1, into two different orbits. **Here are the details of the launch and payloads:**

- The PSLV-C35 was launched from the first launch pad of Satish Dhawan Space Centre SHAR, Sriharikota. The total weight of all the eight satellites is about 675 kg.

- The SCATSAT-1 was released first into a 730 km Polar Sunsynchronous Orbit (SSO) after about 17 minutes and the rest was injected into a lower orbit of 689 km after around two hours. The flight is PSLV's longest ever. There were two re-ignitions of the launch vehicle for this purpose. The launch team engineers shut down and restarted the fourth and last stage of the vehicle twice during the flight.

- Besides SCATSAT-1, the others are PRATHAM and PISAT, two academic satellites from India; ALSAT-1B, ALSAT-2B and ALSAT-1N (all from Algeria); and Pathfinder-1 and NLS-19, from the USA and Canada, respectively.

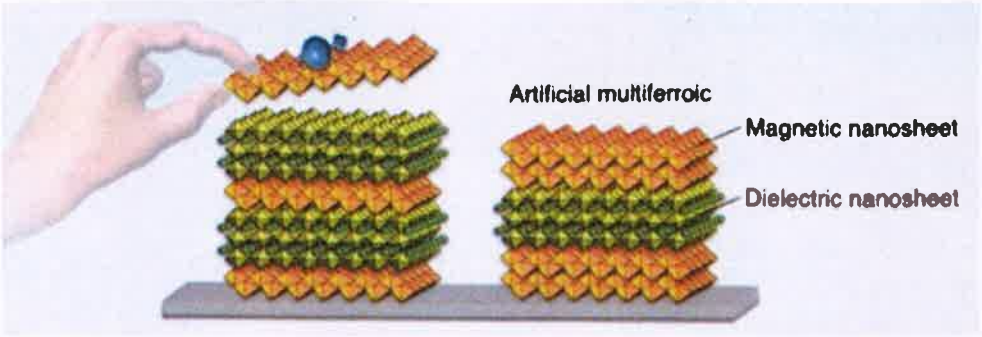
- This was the 15th flight of PSLV in 'XL' configuration with the use of solid strap-on motors. The mission objectives of SCATSAT-1 are to help provide weather forecasting services, cyclone detection and tracking. It has a design life of 15 years.

- The five-kg student satellite PISAT carries an imaging camera as payload to capture imagery of 185 km x 135 km area with about 80m/pixel resolution. The satellite is developed by students of PES University, Bengaluru. The other student satellite, PRATHAM, is developed by IIT Bombay.

- The PSLV has so far launched 39 remote-sensing satellites of ISRO, including the Chandrayaan-1 of 2008 and the Mars mission of 2013-14. It has also orbited 74 foreign commercial and university satellites in a global trend where the demand for its category of launch services is increasing.

Source http://www.satellitetoday.com/launch/2016/09/26/isro-successfully-launches-eight-satellites/

8. New Multiferroic Materials from Building Blocks



A chemical design strategy for creating artificial multiferroics using oxide nanosheets.

A research group in Japan successfully developed room temperature multiferroic materials by a layer-by-layer assembly of nanosheet building blocks. Multiferroic materials are expected to play a vital role in the development of next-generation multifunctional electronic devices. A research group from International Centre for Materials Nanoarchitectonics (MANA), National Institute for Materials Science (NIMS), successfully developed room temperature multiferroic materials by a layer-by-layer assembly of nanosheet building blocks. Multiferroic materials are expected to play a vital role in the development of next-generation multifunctional electronic devices. The design of new multiferroics, or materials that display both ferroelectricity and ferromagnetism, is of fundamental importance for new electronic technologies. However, the co-existence of ferroelectricity and magnetic order at room temperature in single compounds is rare, and heterostructures with such multiferroic properties have only been made with complex techniques (such as pulsed-laser deposition and molecular beam epitaxy). Seeking to develop room-temperature multiferroics, the research group utilized a new chemical design for artificial multiferroic thin films using two-dimensional oxide nanosheets as building blocks. This approach enables engineering the interlayer coupling between the ferromagnetic and ferroelectric orders, as demonstrated by artificial superlattices composed of ferromagnetic Ti0.8Co0.2O2 nanosheets and dielectric perovskite-structured Ca2Nb3O10 nanosheets. The (Ti0.8Co0.2O2/Ca2Nb3O10/Ti0.8Co0.2O2) superlattices exhibit the multiferroic effects at room temperature, which can be modulated by tuning the interlayer coupling (i.e., the stacking sequence). This study opens a pathway to create new artificial materials with tailored multiferroic properties. In addition, the successful development of room temperature multiferroic nanofilms may lead to their application to new memory devices, taking advantage of their multifunctionality and low-voltage operation.

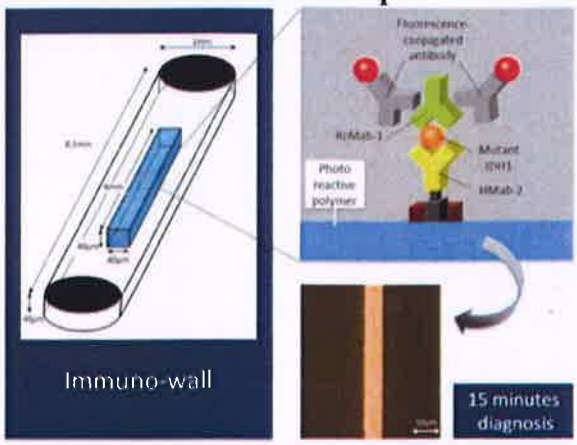
Source https://www.sciencedaily.com/releases/2016/10/161003094219.htm

9. Innovative Molten Silicon-Based Energy Storage System

A team of researchers from Solar Energy Institute at Universidad Politécnica de Madrid (UPM) are developing a novel system that allows the storage energy in molten silicon which is the most abundant element in Earth's crust. The system aims to develop a new generation of low cost solar thermal stations and becoming an innovative storage system of electricity and cogeneration for urban centres. The unstoppable progress of renewable energy, especially wind and photovoltaic energy, has given rise to a global challenge in the energy sector: the storage of such dispersed and intermittent energy. In recent years, a large number of devices have been developed for this purpose. Some of these devices have reached the advanced testing phase and even the commercialization phase. And this is the case of the solar thermal energy, in which sunlight is stored as heat molten salt, and then the energy is and converted to electricity upon demand through a thermal generator. However, there are still problems with the existing solutions due to excessive costs, safety problems or lack of material resources in the future. Therefore, research centres and companies worldwide are seeking alternative solutions by using low cost and abundant materials lacking of great risks to the safety of people. Researchers from Solar Energy Institute at UPM are developing a new energy storage system in which the entry energy, either from solar energy or surplus electricity from a renewable power generation, is stored in the form of heat in molten silicon at very high temperature, around 1400 °C. Silicon has unique properties that confer the ability to store more than 1 MWh of energy in a cubic meter, ten times more than using salts. Molten silicon is thermally isolated from its environment until such energy is demanded, when this occurs, the heat stored is converted into electricity. A researcher said, "At such high temperatures, silicon intensely shines in the same way that the Sun does, thus photovoltaic cells, thermophotovoltaic cells in this case, can be used to convert this incandescent radiation into electricity. The use of thermophotovoltaic cells is key in this system, since any other type of generator would hardly work at extreme temperatures. In addition, these cells can produce 100 times more electric power per unit area than conventional solar cells. These thermophotovoltaic cells are able to reach higher conversion efficiencies, even over 50%. The final result is extremely compact system with no mobile parts, silent and able to store up to10 times more of energy than existing solutions using abundant and inexpensive materials. The first application of these devices is expected to be in solar thermal energy sector, thus avoiding the complex systems that use heat transfer fluids, valves and turbines to produce electricity. By simplifying the setting, the energy costs generated could dramatically reduce, and along with a higher storage capacity can turn this solution into a profitable solution system and an appropriate alternative of renewable generation. These systems could be also used to storage electricity in the housing sector and to manage all energy needs (electricity and heating) in urban areas at medium and long term. The team of UPM researchers are starting to manufacture the first lab-scale prototype.

Source https://www.sciencedaily.com/releases/2016/10/161007100750.htm

10. New Device Enables Rapid Identification of Brain Cancer Type and Tumour Margin



Immuno-wall chips with the photoreactive polymer in the center of the 40 microchannnels are made with a biotinylated anti-R132H-IDH1 antibody (HMab-2), an anti-wild-type IDH1 antibody (RcMab-1), and fluorescent antibodies. It shows sensitive and specific fluorescence from mutant IDH1.

Research team centered at Nagoya University develops a device for quick, accurate identification of a mutation strongly associated with a cancer that affects the central nervous system, potentially enabling accurate removal of the entire tumour during an operation. Gliomas are tumours occurring in the brain or spinal cord. They are difficult to treat as they lack clear edges; which complicates full surgical removal. This leads to high levels of recurrence and mortality. However, previous findings have identified a particular mutation very common in gliomas but rare in other cancers and in normal tissue. Researchers centered at Nagoya University have now developed a micro-sized device that can determine whether a sample is positive for the mutation using only a small sample. This novel approach takes less than 15 minutes. This potentially allows surgeons to identify the specific type of brain tumour and delineate its margin, in real time during surgery, enabling full removal while sparing normal brain tissue. The researchers reported their breakthrough device, which they call an "immuno-wall microdevice," in Science and Technology of Advanced Materials. The device features a chip with an attached highly specific antibody, HMab-2, produced by Yukinari Kato at Tohoku University. This binds to the protein produced by the gene in which the mutation has occurred. When a sample containing the mutated protein is added to the device, the protein binds to the antibody, which is then specifically detected by a source of fluorescence. In contrast, if the sample is from normal tissue without this mutation, or is from a tumour other than a glioma, no fluorescence occurs. "The immuno-wall determines whether a sample is positive for a specific mutation in the isocitrate dehydrogenase 1 gene, which is present in around 70%-80% of grade II and III gliomas," co-author Toshihiro Kasama says. "Our results for a range of cancerous cell lines and actual tumour samples both positive and negative for this mutation were very promising." The device was proven highly accurate, as confirmed by complete sequencing of the gene in question in each sample. The small sample size required for the device reduces the invasiveness of sample harvesting. In fact the process takes only 15 minutes, enabling completion during an operation. The immuno-wall could markedly increase success of glioma treatment by rapidly providing data to inform the course of the operation and tissue to remove. "Our data indicate that a sample with just 500 cells or 500 ng of protein is sufficient to give a positive result," lead author Akane Yamamichi says. "The key to success in the immuno-wall assay is that we, luckily, have HMab-2, the highly specific antibody to the mutant IDH1. This means the immuno-wall can identify the margins of tumours where only low numbers of cancerous cells are present." Alternatively, sampling could even involve only obtaining blood or cerebrospinal fluid, rather than removing brain tissue, making the procedure even less invasive.

Source https://www.sciencedaily.com/releases/2016/10/161004223945.htm

Engineering Innovation in India

Four R&D Institutes receive CSIR Technology Awards 2016 at CSIR Platinum Jubilee Celebrations

CSIR Technology Awards 2016 under category of: Life Sciences, Physical Sciences including Engineering and Innovation were awarded on the occasion of CSIR Foundation Day on 26 September 2016. The awards were given away by Dr. Harsh Vardhan, Union Minister for Science & Technology and Earth Science to the winners during the Platinum Jubilee Foundation Day of the CSIR. This year the winners were: CSIR- National Botanical Research Institute (CSIR-NBRI) and CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow; CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun; and CSIR-National Aerospace Laboratories, Bengaluru. The awards for Physical sciences were conferred to the following.

- **CSIR-Indian Institute of Petroleum (CSIR-IIP), Dehradun** has won the award for development of Wax De-oiling Technology and its Commercialization at Numaligarh Refinery. A state-of-the-art 'Wax De-oiling Technology' with high energy efficiency, low carbon footprint and low capital cost for producing 'Paraffin' and 'Microcrystalline' waxes has been commercialised in collaboration with Engineers India Limited (EIL) and Numaligarh Refinery Limited (NRL). Based on the techno-commercial inputs from CSIR-IIP and EIL, NRL has set-up the first ever wax plant based on indigenous technology. This wax plant built at a cost of Rs. 676 crores is designed to produce 50,000 Metric Ton Per Annum (MTPA) of high quality and high value 'Paraffin Wax' and 4,500 MTPA of 'Microcrystalline Wax' for making tyre and rubber, candles, adhesives, corrugated board, cosmetics, casting etc.

- **CSIR-National Aerospace Laboratories, Bengaluru** has won the award for LED Based DRISHTI Visibility Measuring System. Drishti is a visibility measuring system installed at Indian airports to give information to pilots on the visibility at the runway for safe landing and take-off operations of aircrafts. It is mandatory category transmissometer. Transmissometers installed at various Indian airports have been of foreign origin. The high cost of imported devices and complications observed in maintaining them necessitated indigenous development of Drishti, a cost-effective and highly precise system. Drishti stands on par with or better than the imported transmissometers. It has provision to get multi systems visibility data in a single computer with remote health monitoring, multiple display modules, web enabling of data, secured encrypted communication of data from Runway to ATC and many more. Further, Drishti is1/3rd the total cost of imported system. The state-of-the-Art Drishti system with unique innovative design of the entire hardware (both opto-mechanical and electronic) and software developed with virtual instrumentation concept has made a paradigm shift. Drishti is for all categories of Airports, viz., CAT I, CAT II, CAT III A & B. 27 numbers systems of DRISHTI have been installed in 10 international airports, 70 systems are being installed in other civilian airports while 54 systems are planned for IAF Airbases. The next-gen Drishti to address the needs of Railways and Roadways is on the anvil.

Source http://skilloutlook.com/2016/09/27/four-rd-institutes-receive-csir-technology-awards-2016-csir-platinum-jubilee-celebrations/