INDIAN NATIONAL ACADEMY OF ENGINEERING

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From the Editor's Desk

Vital Engagement

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Purnendu Ghosh
Chief Editor of Publications

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The leader of a vitally engaged organisation knows how to agree, how to disagree, how to differ, and also knows how to express emotions, feelings, knowledge and attitude. He knows, "how can I do less of what I don't do quite well in order to maintain and improve the quality of what I know I can do better." He knows how to utilize 'mediocre and minimal resources' optimally.

There is sometimes a conflict between a person's values and the values of the organisation. What one does well may not fit with the organisation's value system. There can also be a difference between 'actual' and 'organisationally required' emotions. A vitally engaged person understands the implications of these differences and uses it to resolve conflicts that may arise.

ACADEMY ACTIVITIES

Academy Announcements

Dispatch from INAE Secretariat

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The nominations for the above are requested from the engineering colleges/institutions. In case the above forms have not been received, the same may be downloaded from INAE website www.inae.in and sent to the INAE Secretariat within the stipulated date.

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INAE expert Pool has been created with the aim of identifying domain experts in various disciplines of engineering. The creation of this pool was discussed in the recent meetings with DST and Technology Information, Forecasting and Assessment Council (TIFAC). During the meetings, it has been decided that the domain experts from the Expert pool would be identified and selected for initial peer review by a group of experts for screening and assessment of the project proposals received by DST and TIFAC, from time to time. In addition, the Fellows would also be identified from the Expert Pool to form part of the Project Monitoring Committees (PMC), for projects sanctioned under the aegis of DST and TIFAC. Similar efforts are ongoing for further utilization of the INAE Fellows as domain experts in ongoing programmes of national

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10th National Frontiers of Engineering (NatFoE) Symposium

The 10th National Frontiers of Engineering (NatFoE) Symposium is being held on Jun. 23-25, 2016 at Indian Institute of Technology (IIT) Kanpur. Prof Sanjay Mittal, FNAE is the coordinating the event along with Prof Yogesh Joshi and Prof Kantesh Balani of IIT Kanpur. The four themes of the Symposium are on "Flexible Electronics"; "Laser Engineering and Technology"; "Multifunctional Biomaterial Technology" and "Smart Cities".

Engineers Conclave 2016

INAE has been making efforts to present the recommendations on important themes of National importance to the appropriate agencies. Engineers Conclave 2016 is being held at Indian Institute of Technology Madras during Sep 1-3, 2016. Prof. Bhaskar Ramamurthi, FNAE, Director, IIT Madras and Dr BN Suresh, President, INAE are the Co-Chairs of the Engineers Conclave 2016. The themes of the Conclave are "Engineering Education" to be coordinated by IIT Madras and "Smart Cities" to be coordinated by INAE. Prof. MS Ananth, FNAE is the Coordinator from IIT Madras for Theme I on "Engineering Education". Theme I on Engineering Education shall have the following sub-themes: Industry Expectations; Curriculum and Flexibility; Pedagogy; Start ups; Research Excellence; Quality Control; Skill Development and International Comparisons. Prof Prem Krishna, FNAE is the Coordinator of Theme –II on "Smart Cities" which shall have the following sub-themes- e-Governance/ICT Enabling; Urban Water Management; Healthcare/Sanitation; Transportation & Infrastructure and Energy & Ecology.

Meeting of the INAE-TIFAC Working Committee on 12th April 2016

A Meeting of the INAE-TIFAC Working Committee along with the Conveners of INAE Sectional Committees was held on 12th April 2016 at Technology Information, Forecasting and Assessment Council (TIFAC), Vishwakarma Bhawan, New Delhi. The objective of the meeting was to discuss

the joint activities between INAE and TIFAC in the areas identified in the Vision Document 2037 by INAE and TIFAC Technology Vision Document 2035.

Annals of INAE

The soft copy of the Annals of the INAE Volume XIII, April 2016 containing the text of the lectures delivered by Life Time Contribution Awardees; Professor Jai Krishna and Prof. SN Mitra Memorial Awardees, newly elected Fellows of the Academy and INAE Young Engineer Awardees during the year; can be downloaded from the link https://www.dropbox.com/s/b3vyi5d029krakf/Annals%202016.pdf?dl=0

Research Journal -INAE Letters

The Agreement for publishing the Research Journal "INAE Letters" has been concluded with M/s Springer as approved by the Governing Council. The website for the Research Journal "INAE Letters" to include facility for submission of papers online has been launched. The first issue of the Research Journal "INAE Letters" will be released shortly.

Academia Industry Interaction

AICTE-INAE Distinguished Visiting Professorship Scheme

Industry-academia interactions over technological changes have become essential in recent times so that relevant knowledge that would be sustainable in the changing conditions can be imparted to the students in the engineering institutions. While industries could gain by using the academia's knowledge base to improve the industry's cost, quality and global competitive dimensions; thereby reducing dependence on foreign know-how and expenditure on internal R&D, academics benefit by seeing their knowledge and expertise being fruitfully utilized practically and also by strengthening of curricula of educational programs being offered at engineering colleges/institutions. INAE together with All India Council for Technical Education (AICTE) launched "AICTE-INAE Distinguished Visiting Professorship Scheme" in 1999. Under this scheme, Industry experts are encouraged to give a few lectures in engineering institutions. This scheme has become popular among industry experts as well as engineering colleges.

Brief details pertaining to recent visits of industry experts under this scheme are given below.

Dr Chaitanyamoy Ganguly Retired Distinguished Scientist, DAE	Jadavpur University, Kolkata April 25-26, 2016	Delivered lectures on "The Role of IAEA in spreading peaceful use of nuclear energy-opportunities for young nuclear science and engineering graduates and post graduates to avail IAEA internship" and "Accident Tolerant Fuels foe Light Water Reactors". According to the feedback received from the faculty coordinator of the engineering college, the sessions were extremely useful in identifying the areas of meaningful research.
Mr S Madivaanan, Formerly Additional Director, CVRDE	Velammal Engineering College, Chennai April 15, 2016	Delivered lecture on "Control System Applications in Defence". Also guided project on "Unmanned Vehicles, automated Test Equipments for testing MBT Systems" and given inputs to update existing syllabi. According to the feedback of the faculty coordinator, this scheme helps to have an interaction with Industry Expert and also in getting wider knowledge for budding engineers and faculty members. It also helps the students to carry out good innovative projects.

International Conferences/Seminars being organized by IITs/other Institutions

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

Honours and Awards

1	Dr RK Bhandari, FNAE, Formerly Director, Central Building Research Institute, Roorkee & Programme Director, UN-HABITAT, Nairobi and Formerly Chairman, Centre for Disaster Mitigation and Management, VIT, Vellore was conferred the Lifetime Achievement Award by the Quantum Global Campus, Uttarakhand on April 16, 2016 in recognition of his unparalleled journey of achievements and attainments.

News of Fellows

1	Prof Bimalendu B. Bhattacharya, FNAE, formerly INAE Distinguished Professor, Satyendra Nath Bose National Centre for Basic Sciences; Formerly Director Indian School of Mines, Dhanbad and Chairman, Research Council, CSIR-NGRI, Hyderabad has just brought out a book titled "Geoelectric Methods: Theory and Applications" co-authored with Shalivahan and published by McGraw Hill Education.

3rd International Conference on Electrical, Electronics, Engineering Trends, Communication, Optimization and Sciences (EEECOS/E3COS)-2016 on June 1-2, 2016 at Tadepalligudem, Andhra Pradesh,
http://www.conferencealerts.com/show-event?id=169700

2nd International Conference on Innovative Trends in Mechanical and Civil Engineering on June 10, 2016 at Vallioor- Tirunelveli, Tamil Nadu,
http://www.conferencealerts.com/show-event?id=171200

Sixth International Congress on Computational Mechanics and Simulation on June 27 – July 1, 2016 at IIT Bombay, Mumbai
http://www.iccms2016.org/

6th International conference on "Advance Trend in Engineering, Technology and Research (ICATETR-2016)" on 30th June to 1st July 2016 at Kota, Rajasthan,
http://www.conferencealerts.com/show-event?id=170782

Nurturing Engineering Talent in the Aerospace and Defence Sector

K.Venkataramanan

1.0 Outlook of India's Aerospace &DefenceSector

The Indian aerospace industry has become one of the fastest growing aerospace markets in the world, primarily due to the increase in defence spending and a growing commercial aviation market. The rapid growth of this industry has attracted major global aerospace companies to India and has boosted the confidence of domestic aerospace players to increase and deepen their operations.

India's defence industry which has seen a steady growth in recent years, seems poised for even better days. Growth in domestic demand looks promising and the Government has a clear vision for an indigenous defence industry. The defence companies across the globe are increasingly looking at India as a lucrative sourcing hub, in order to remain globally competitive. India has a tremendous potential for exporting engineering services and component manufacturing capacity in these sectors.

With the Government of India now encouraging indigenous development in the Aerospace & Defence (A&D) sector in a big way through its "Make in India" initiative, huge investments are expected in the A&D sector in the areas of manufacturing. India is rapidly building capabilities to emerge as a preferred destination for manufacturing of aerospace components. India's real and sustainable advantage lies in demonstrating our expertise in the entire process, beginning right from the initial design to final manufacture. The industry is surely poised for an exponential growth in the coming years.

The A&D sector in India is now being looked at as the sunrise sector and it has the potential to generate a large number of engineering jobs in the years to come. One of the major challenges ahead for the Aerospace and Defence (A&D) organizations is: how to effectively the manage this engineering talent. Organizations are in need of science, technology and engineering talent to cater to the future growth. They require engineers with highly specialized skill sets to cater to their niche requirements. Attracting and retaining critical talent is increasingly viewed as a top strategic issue by the senior management and human resources executives in this sector.

Addressing these challenges requires a comprehensive transformation, the requirement of which stems from the challenges that the A&D industries face due to the mismatch between their requirements and the skills with which the aspiring engineers join these organizations. There is a need for a radical change in the present style of pedagogy being employed in many of the engineering institutes. On the other hand, there is an equally important need for a change in the working style of A&D industries to overcome their existing workforce challenges. Hence, there are efforts and steps required from either side, from the industries and the institutes, so as to better align the engineering workforce with the industry requirements.

2.0 An Engineer's Mind and Aspirations

An engineer's mind is highly inquisitive. Engineers have the tendency to question the actual physics behind any process. Young engineers, who are fresh pass-outs from the institutes, are high on

inquisitiveness and creativity quotient. They are fascinated to see how the machines are being designed and built to achieve magnificent goals and how modern technology influences our day-to-day life. Young engineers enjoy taking up challenges. They are driven by the desire to apply the lessons they have learnt in the classroom to the outside world. Engineers today are expeced to think out of the box, examine and analyze things critically and come up with solutions and improvements which would have been considered unattainable even a decade ago.

However, when it comes to choosing organizations where they would aspire to work, we normally come across one category of engineers who are driven more towards what we may call an AC-PC (office room with an AC and a PC) kind of work culture. They do not seem inclined to take up the rigorous work at site or in shop-floor. But there will always be young engineers who get excited by things where they see a purpose, get motivated by a formidable challenge and work which would give them a sense of pride and great professional satisfaction. Working for projects like the "*First indigenous nuclear submarine built in India*" or "*First Indian PSLV to travel on lunar mission*" get them excited more than anything else.

It is indeed very heartening to see the recent trends, which indicate that the present generation of engineers are more drawn towards organizations which provide them with opportunities to work on grass-root innovations, big challenges or social sector applications where they get to implement their ideas through the high-end technology or digital platforms.

3.0 Need for a Radical Change in Engineering Pedagogy

At engineering colleges we are taught how things work, but as practising engineers we have to understand how things can fail as well. Bringing reliability to a product is nothing but to understand the underlying failure mechanisms and generate methodologies to mitigate the failures. Engineering curricula must, therefore, be able to bring such practical orientation into academics and offer budding engineers a true "feel" of the reality outside the classroom.

To be successful as an engineer in this age, one needs to have the technical competence and excellence which comes from a combination of a sound theoretical knowledge imparted through classroom teaching and applied knowledge which comes from industrial exposure and industry-oriented training. It is a good sign that some engineering institutes are introducing "practice schools" for final-year engineers, in place of traditional academic projects.

The purpose of engineering education is to develop the candidate's abilities of analysis, design, application and engineering judgement, while deepening the understanding of engineering fundamentals. The pedagogy currently followed in many universities has following shortfalls:

- Many engineering students find some courses including design courses difficult to grasp or understand in totality, primarily because most of the instructors lack the necessary practical experience to relate fundamentals to practice and to give a real-life orientation to learning. This hampers the student's ability to handle practical problems.

- Many educational institutes lack of the requisite computer hardware and the latest engineering software tools presently used in the industry. This makes the students feel "alienated" when they come out in the industry and are required to use such tools in a big way.

- Some universities cannot set up laboratories because of the shortage of funding and the lack of specialized teaching staff. These factors also attribute to incomplete understanding of engineering fundamentals.

- In traditional teaching methods, students study fundamentals according to predefined steps to acquire certain results and to prepare for examinations based on a well-defined pattern. The teaching methodology rarely encourage independent thinking or application-based learing. This makes it difficult to nurture innovation and creativity.

Therefore, it is necessary to reform the current teaching methods by focusing more on application of learning, out-of-box thinking together with innovative and entrepreneurial outlook. Wherever possible budding engineers nedd to be encouraged to develop a holistic view. For instance, engineers need to realize how the scientific principles derived from basic research, as depicted in Figure 1, attribute to developing the technology and know-how through applied research and how such know-how translates into tangible products and processes. It is imperative for young engineers to implement this value-chain in practice so as to make a visible impact in their professional career.

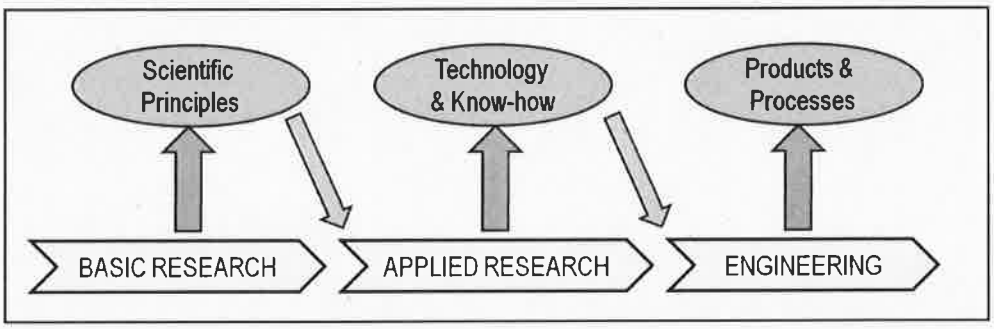


Figure 1: Clarity on Interdependence to be offered by Engineering Education

4.0 Industry Requirements *vs* Output from Academia

Engineering excellence has always been the critical capability for aerospace and defence. The nature of the work assigned to our engineers is constantly evolving with changing requirements and with varying magnitudes of complexity. It calls for a multi-disciplinary approach and additional soft skills which is not what our engineers are normally trained for. It calls for speed and continuity to execute complex projects associated with these A&D programs, which have longer life cycles and tend to drag indefinitely at times. Today, be it any industry including A&D, only fraction of the workforce is completely trained and qualified to carry out the work that they do. Employers have to invest considerable time, effort and money to make the fresh engineers "job-ready" and readily "billable". We need to face the reality that majority of the graduating engineers today are not directly "employable" and both Industry and Academia need to collaborate effectively to bridge the gap beteen Industry requirements and the output coming out from academic institutes. The *National Knowledge Functional Hub* (NKFH) initiative - a collaborative framework between Industry and Academia with a national footprint - launched by the Federation of Indian Chambers of Commerce & Industry (FICCI), is actively addressing this critical issue.

5.0 Managing the Engineering Workforce

The A&D industries, like any other sector, face several typical challenges when it comes to managing the engineering workforce. These include:

- Having the required number of engineers on board
- Developing the engineering capabilities needed for future competitiveness
- Attracting and retaining the engineering talent

5.1 Having the required number of engineer on boards

Given the growth anticipated inthe A&D industry and with changing demographics (specifically, with a large number of existing senior staff approaching retirement), there is a concern about

sustaining the core engineering talent. Though the optimal number of engineers the companies should have is not static, they need to ensure a relatively steady intake of engineers looking at the series of long lead A&D programs in pipeline. As one program ends, a new one begins. As a result, a sufficient base will have to be maintained to absorb the engineering capability and the new engineers will have sufficient time to "cut their teeth" before they get fully engaged with live projects.

5.2 Developing the engineering capabilities needed for future competitiveness

The landscape in A&D is evolving, which has significant implications for the industry's engineering needs. Some of the biggest development programs are now moving into production and other programs are likely to follow, which call for enhanced design and manufacturing skills. There is a tremendous emphasis being laid on necessary skill and capability development, which is one of the driving factors behind "Make in India" initiative.

5.3 Attracting and retaining talent

A&D industry's twin challenges of sustaining a mature engineering workforce and meeting intense competition for younger talent from other industries are well known. A common situation in A&D engineering departments today is a shortage of early and mid-career talent to compliment the experienced engineers.

Looking at the prevailing situation, the imperatives for the A&D sector should be to recruit more creatively, create a well-designed career track for top talent and implement a formal knowledge transfer mechanism from experienced to young engineers, particularly tacit knowledge and experiential learning.

6.0 Towards Better Industry-Academia Alignment

As already mentioned, the engineering institutions and universities produce graduates with basic academic qualification as per prevalent curriculum, but their skills and capabilities often do not meet the current industry requirements. Key shortcomings appear to be the inability to relate class-room learning to practical situations, adopt innovative ideas to face unfamiliar problems and display required "soft skills", specially the people management abilities. Some of the obvious expectations from young engineers are that they should be creative and able to work well in teams, communicate effectively, define problems, consider alternatives, come up with innovative solutions and appreciate the uncertainties of "real world" environment, where not everything is well-defined or well-understood.

Industry and Academia need to collaborate to ensure that fresh engineers are equipped with the necessary technical capabilities as well as "soft skills". Both the entities can play a key role in helping the future engineers with active support in the following areas:

*6.1 Improving the **"Soft Skills"***

To address the need for students to acquire soft skills, some engineering institutes have already associated with the industry and consultants to understand the factors associated with soft skill development. The idea is to create a teaching environment that fosters holistic development of students by making them work in teams, do hands-on projects in institute as well as industry and actively engage with professional societies.

*6.2 Maintaining the**"Right Balance"***

Today's engineering students face the challenges of a demanding curriculum, long study hours and a heavy course load. These are particularly daunting for first-year students, most of whom are also required to adapt to the challenge of being away from home for the first time and being responsible

for more than just their academics. All this can lead to poor academic performance and stress-induced problems, requiring professional counselling.

One successful model for helping students not only cope but also thrive forward is by maintaining the right balance between the "course load and pressure of exam performance" on one hand and the opportunity of "Learning and Application" on the other hand. This can enable the students to face their academic challenges in a proactive and relaxed way and also inculcate "learning by doing" habit right from the beginning of their professional life.

*6.3 Introducing **"Real World"** Engineering*

For most engineering students, understanding theoretical concepts and applying these to practical situations with the right context is critical to their success in the classroom and eventually in the workplace. Industry and Academia can join hand in developing a curriculum that allows engineering minds to relate the theories to pracice and appreciate the challenges and uncertainty in real-life applications.

*6.4 Encouraging **"Internships"** and **"Industry Projects"***

It is encouraging to see that most of the leading academic institutes today are emphasizing the need for student interships and industry-based projects as a mandaotory part of their curriculum, with assigned credit points. This can be a key enablers for young engineers to appreciate their classroom learning better and to understand how the industry functions and what it takes to succeed as a practising engineer. A spin-off benefit from such initiative is that faculty members also get better tuned to the industry realities and get an opportunity to enrich their teaching and research work to make these better aligned with industry requirements. This in turn benefits the students in the long run.

7.0 Skill Development and Innovation

Skill Development is being viewed today as a necessity at the national level in order to transform the "Make in India" dream into reality. While this applies to all industry sectors and all the professions, the need is even more acute for the skill-building of our engineering talent in A&D sector. The movement is essentially a collaborative, multi-dimentional engagement process with many stakeholders, as shown in Figure 2.

Industries need to facilitate the creation of a well-defined set of "Occupational Standards" for the engineering profession, together with appropriate innovation ecosystem. The Academia, on the other hand, needs to ensure that the identified skill sets are being adequately covered in engineering curriculum. Enhancing the efficiency at all levels of operation and sharing of knowledge across stakeholders will be the key to success.

Figure 2: Making 'MAKE IN INDIA' a Reality

Going beyond Skill Development, institutionalizing an "Innovation Culture" will involve additional considerations, as shown in Figure 3. If it is our aspiration to see future engineering talent in Aerospace & Defence sectors as the drivers of innovation and entrepreneurship, then the enabling process should necessarily start in the classroom itself.

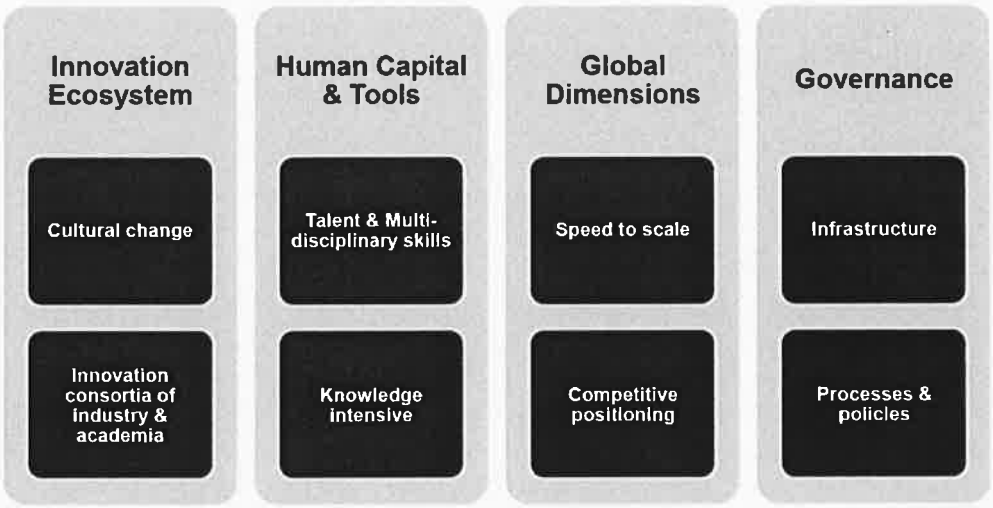


Figure 3: Innovation Pillars

8.0 Conclusion

Going forward the A&D sector is poised for a steady growth, driven by the indigenous development and manufacturing aimed by the "Make in India" campaign. Managing the engineering talent to take up the speed and scale required to keep up to the targeted growth in the sector is going to be the most crucial factor. Recognizing the issues and implementing necessary changes to better align the engineering pedagogy with the external industrial needs is of paramount importance. It is equally important to overcome institutional inertia and enable sustainable improvement in processes dealing with teaching, training and nurturing young engineering talent. Industries in the A&D domain must create a better value proposition for talent and instil a culture of performance management. Organizations that effectively pursue and maintain such transformation will be able to create a competitive advantage with respect to the engineering talent they possess. We in India have the potential of harnessing the best engineerning minds in the world, but it will require a quantum shift in our mindset towards engineering education and a committed and sustainable effort among all stakeholders.

Exciting Moments of Research

Jayanta Mukhopadhyay

When I joined the PhD program at my own alma mater, the very first question bugged me was, what I was supposed to do to qualify as a researcher? The other obvious question was why the Government was paying me a scholarship or fellowship? Was it meant for demonstrating creativity on my intellectual exercises? Was it a kind of support from the society, as it extends to other forms of recreational arts and faculty? Did my country really expect me to solve a burning problem, which would bring the progress and prosperity of this nation? Frankly, I was confused and I should admit that till date, there is no qualitative change in the state of my confusion in this regard. However, I started on my own way looking at various issues on a research area of electrical sciences called image processing, without bothering much about their impact and applicability.

Search for something .....

In my early research days I had the least idea about what I was going to do and what excitement awaited me in future. Of course I was very much excited to dream that excitement. Nevertheless there were other motivations also to pursue the doctoral degree. I wanted to be in academics and realized; that freedom can be bought by having a PhD degree. So I wanted the degree as quickly as possible. I was fortunate in various ways. I had wonderful friends, who also joined PhD programs of my Institute around the same time. The ambience surrounding us was intellectually vibrant with a mood of great expectation and excitement for coming days. Above all, my supervisor (Prof. B.N. Chatterji), one of the nicest persons I know, gave me all the liberty of choosing my research problem and carrying out my study in my own way. Frankly, it was an adventure for all of us. We didn't really know what the things to prove were, but we wanted to prove something. It was that search for 'something' initiated my research career.

In those days, it was not easy to get reading material, in particular the published work in journals and conferences related to your field of interest. Our main resource was our library. It was quite a thrilling experience to walk down the semi dark allays of the bound-journal section of the library and then started looking for a paper you intended to read. I can tell you, the joy of getting the desired one is no less than the discovery of an island after an uncertain voyage across the ocean. Sometimes, we used to mail our reprint request, specially printed on a post-card size hard paper, to a researcher in foreign lands. Before it got lost into oblivion, you would be surprised to get a delivery suddenly with compliments from your peer researchers. Those were my prize collection and still I am having them in a few bound volumes. Now-a-days, we have the comfort of getting almost any work by the mouse-click from the digital library of our Institute and also some of them are available free in the internet. Even requesting an article from its author by sending an email is a rare phenomenon. Though digital connectivity has opened up the much coveted store house of knowledge and information, it has robbed the excitement of uncertain walk through among the journals and magazines lying in the corridors of a library.

First research problem ...

My first research problem started with designing an algorithm for thinning a 3-D object, which is represented by discretization of its spatial occupancy in a 3-D binary array. The problem was

introduced to me by my friend Dr. P.P. Das (PPD). In his Master's thesis he implemented a known 2-D thinning algorithm. When I approached him for a possible research problem, he suggested me, "Why don't you extend the algorithm to 3-D?" The next day, I came up with a solution with full implementation and results. The thinning of a pattern may be carried out by iterative deletion of boundary points, till the pattern gets fragmented or eroded completely. It provides a skeletal representation of the object. In the 2-D algorithm, there are a few neighboring conditions to be checked for a point before its safe deletion. I simply extended these conditions to 3-D. Fortunately, the work got accepted without any trouble in an international journal, which happened to be my first published research paper in a journal. Interestingly, a few months later, we got a rebuttal from two researchers, who showed and proved with counter examples that our method has flaws. In some cases, 3-D patterns loose connectivity. The editor-in-chief of the journal was kind enough to forward their criticism to us for a review. Not only we accepted it, but also we came up with an improvised version of the algorithm which got published along with the criticism in the same issue of the journal. It made me happy twice - it increased my understanding of the problem and it also increased my paper count! The incident was a good lesson to me. It revealed that we should not be afraid of criticism, which actually helps in improving ourselves. Sometimes we felt terrible when we find our work got rejected by our peer reviewers and our instant reaction appears to be a lamentation on the injustice ushered from irrational reviews! It should be otherwise. We should be positive enough to look for exciting revelations out of those comments and criticisms, and engage ourselves to resolve issues, that rise subsequently. Research is exciting as long as you are in the process of improving and developing your work.

Cooked up problems ...

In those days I read a little, but worked more on my own ideas. I must admit it is not an ideal research methodology. Probably the pasture was green enough to get my work published in some of the reputed international journals. I do not think in today's research work it is advisable. We should have sufficient background information and knowledge about the topic of our research. In the past, our window to the outside world was also smaller and we needed to dream on our "cooked up" problems more than studying the real world applications. I was working on recognition of 3-D objects without even having any access to a digital camera. In fact I was looking for 3-D real life images for testing my algorithms and techniques, which were mainly developed on synthetic data set of small 3-D binary arrays. I soon found that the kind of data I was looking for was partially available in the form of depth maps of visible surfaces, called range images of an object or scene. I did go through a few papers on range imaging and analysis of range images, and started sending my request to peer researchers for providing me sample range data. In one fine morning, I received a big packet from Prof. Kosuke Sato of the Osaka University, Japan, containing the much needed data set in a floppy. However, he also threw me a challenge for deciphering the data file, as there was not sufficient information (or I was not good enough to deal with them readily) in understanding the format of the data. So it took a few days to dig those numbers, to arrange them in a meaningful 2-D array, and finally to get the display of objects on your screen for ultimate confirmation of your prized possession. Looking back, I must say those were my moments of excitement. How little it may appear in today's context, it gave me the opportunity of testing and adapting my algorithms on real life images! It did save my PhD work from being castigated as mere hypothetical exercises!

A few early concepts I was quite enthused about, were the concepts of digital neighborhood plane (DNP) and neighborhood plane set (NPS), which I had introduced for capturing local structural information of a 3-D point. Initially I conceived about nine DNPs each containing at most eight neighboring points. Later, my friends Prabir (Dr. P.K. Biswas) and Vosky (Dr. S.S. Biswas) incorporated four more additional planes which may contain at most six neighbors. The NPS of a point is the set of DNPs on which the point has sufficient numbers of neighbors. Using this feature

we designed algorithms for segmenting 3-D surfaces and for extracting wire-frame structures of 3-D objects.

Distance functions ...

Around same time we were also fascinated about discovering new metrics or distance functions in arbitrary dimension. My friend PPD did excellent work in this area and I was encouraged to join the search for new classes of distance functions. So one morning I went to PPD and suggested a new class of distance function based on t-maximum operations. I was not sure enough whether the function is sufficiently novel. But PPD was quick to fire it up and spent a few days to come up with a set of theorems and proofs elucidating properties of this class of distance function, which we named t-cost distance function.

What fascinated me most are shapes of digital circles and spheres of those distance functions in 2-D and 3-D, respectively. In particular, we observed interesting variations in those shapes for octagonal distances, which are defined from paths generated by a sequence of different types of neighborhood definitions. PPD showed how vertices of these hyperspheres could be computed given the neighborhood sequence of an octagonal distance function. We further simplified this computation and used it for computing vertices of a digital circle and a sphere, in the form of a convex polygon in 2-D and convex polyhedron in 3-D, respectively. When Ashwath (Dr. Ashwath Kumar) joined as a PhD scholar under the joint supervision of me and Prof. Chatterji, I suggested him to develop different geometric computational techniques exploiting their shapes. Subsequently, he came up with efficient techniques for computing geometric transformation, normals at boundary points of 2-D object, and cross-sections of 3-D objects using medial axis transform (MAT) based on octagonal distance functions. He also showed how these transforms are useful in fast rendering of 3-D objects. We studied also the proximity of these distance functions to the corresponding Euclidean norms exploiting the geometry of their circles and spheres. Previous to our technique researchers adopted only the analytical methods for computing the bounds of the deviations from Euclidean norms and obtained the optimum distance functions minimizing these bounds. However, the mathematics involved in this process, may be quite rigorous and in many cases (e.g. for octagonal distance functions), we still do not have such analysis. As our approach was from a different perspective, it gave a new insight to some of these distance functions, which were empirically found to provide good approximations, but remained unexplained from their mathematical properties. Yet, the limitation of our technique lies with its extension to dimensions higher than 3-D. Things get really murky there and I invite budding researchers to take the challenge for finding good approximations of Euclidean norms in higher dimensions using the geometric approach.

A lull period with fractals ...

There are also lull periods in your research career. Particularly, you may feel tired and exhausted with similar nature of research problems and ideas. So in one fine morning you may find that all the excitement of having fresh ideas suddenly vanishes into your routine work and assignments. This is the time; you should ponder yourselves for a new direction. For me it was the fractal modeling of objects and patterns, which drew my attention. I was engrossed with the beauty of those fractal patterns generated from simple mathematical expressions, and interested on modeling 2-D patterns using iterated function systems (IFS), a set of contractive affine transformations. During this period, one of my B.Tech project students did develop a tool for modeling such pattern by covering the target shapes with tiles of different geometrically transformed replica of the same and created artistic scenes of trees, rocks, huts, etc. However, what impressed me the most is the tall claim of getting a very high compression ratio of images using this model, though its algorithm was not published apparently for commercial reasons. Still today I am not sure about its existence. In any

case, I was motivated to look into compression algorithms based on the IFS and took Jacquin's algorithm using partitioned iterated function system (PIFS) as a case study. We studied its convergence properties during decoding and came up with an efficient linear time decoding algorithm, much faster than the iterative process. In this modeling we showed that the image space is partitioned into chains of pixels forming a typical structure named circular plant, which originates from a cycle (called limit cycle). The convergence of the fractal code depends on the convergence of these limit cycles. Hence by tracing a chain backward, we could compute these limit cycles and subsequently could compute the converged values of the pixels in one shot. We also used this concept to design a novel video compression algorithm. In this algorithm with the help of the circular plants of a reference frame other collocated temporal frames are encoded. Unfortunately, the performances of these compression algorithms were so poor compared to the standards such as JPEG, MPEG, etc., that these findings had little impact in this area of research.

Living with ideas ...

In the mean time, I was also attracted to color processing and started playing with colors by changing their saturation and hue following CIE chromaticity chart. In fact, the idea came to me in early nineties while supervising an M.Tech thesis. But it finally got shape when I was visiting the University of California, Santa Barabara (UCSB) in the summer of 2000. Living with an idea and finally exposing it are quite exciting. It happened to me in other cases also. You live with these ideas for years and finally become bold enough to bring it out with much more details and impact. This was also true for our analysis of fractal decoding algorithms, which took around three years to be considered seriously. Very recently, I reported a new class of distance function, named weighted t-cost distances, which was actually conceived around six to seven years back. When you are pondering on research ideas, you have all the excitement of a child, who is impatiently waiting for a grand event being unfolded before him. However, the most difficult stage is the sustenance of that idea and repeatedly revisiting it under various contexts. Finally you have to take a decision for its full exposition. At that stage you are like a director of a movie, who has the sketches of his scenes and shots. You need to choose your actors, their roles and final execution plan with thorough experimentation and theorem proving. In this process, do not expect that the outcome will be always in confirmation of your hypothesis and expectation. However, in most cases, you are sure to reach a state of new realization and confidence in your research goals.

Necessity of survival ...

I started my discussion with a few questions on motivating factors of research. Those questions are bound to occur at various stages of your career in different forms. It ranges from questions related to progress and evolution of human civilization, to mere mundane needs of an individual for getting a degree or promotion. Frankly speaking, motivation of research is multi-faceted. Sometimes it is the product of creativity of your passion; sometimes it is the necessity for the survival of an individual in his / her professional world. I am fortunate to supervise a few students toward their doctoral degrees. Some of them are very bright and capable of carrying their research work almost on their own. They mostly sought my opinion and suggestions on certain matters and queries. Some of them needed my involvement only in the stages of problem formulation, but could carry out on their own thereafter. For an exceptional few, I had to plan for almost everything including writing the codes of implementation. But I am doubly thankful to them for driving and pushing my research agenda. My passion on color processing rose also out of this necessity. I entered into the wonderful world of problems on color constancy, retinex processing and color demosaicing. In the retinex processing, we proposed a network model of retinex computation, which is aimed at annulling illumination variation in a scene toward restoration of colors of pixels. The model was inspired by biological processing that goes in our visual pathway. Color demosaicing is an operation required

for converting a color filter array (CFA), which has only one predetermined color component at every pixel in an interleaved fashion, into a color image with full resolution for every color component. There are various algorithms for this purpose. We proposed a Markov random field (MRF) based post-processing technique for improving the quality of demosaiced images obtained by using any one of those algorithms.

A chance meeting ...

While I was working on this problem, I had the luck of meeting Sanjit-da (Prof. Sanjit K. Mitra of UCSB), who was visiting my Institute in the year 1999. I consider that was one of the important turn around in my research life. That time he was also working with similar problems. He invited me to visit his laboratory in the summer of 2000. I readily accepted. Not only in 2000, I visited his laboratory in subsequent years of 2001, 2003 and 2004. I would have done it every year, unless I got myself busy with the headship of the Computer and Informatics Center of our Institute. When you work and spend time with a person like Prof. Mitra, you have the fortune of getting exposure to different types of problems in the areas of signal and image processing. In particular he drew my attention to the problems of processing in the compressed domain. That is how; I started looking at issues related to development of algorithms for compressed images and videos.

...

I thought that I would try to capture my exciting moments of research. But it ended up with sketches of some of my research problems and a brief history about their genesis. My moments of excitation are hidden under those research impulses. They are under those sudden twists and turns, when out of nothing suddenly you come to realize that there are a few things yet to be done. However little is their impact, you are the only person in this world who thought about it. I had the fortune of sharing these excitements with my teacher, with my students, and with my friends. That is what I enjoyed the most and am still enjoying.

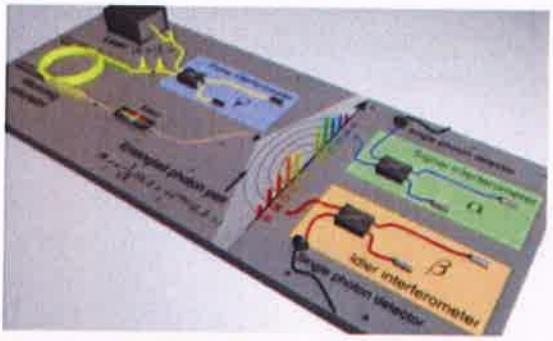
Civil Engineering

1. Roads to Emit Light with Solar Charged Cement

Scientists have created a new light-emitting cement that could last a hundred years and illuminate roads, highways or bicycle lanes at night by absorbing solar energy during the day. Currently, the cement exists in blue or green colour, and the light intensity can be regulated to avoid dazzling drivers. "The main issue was that cement is an opaque body that doesn't allow light to pass to its interior," said Jose Carlos Rubio, from Michoacan's University of San Nicolas Hidalgo in Mexico. Rubio explained that common cement is a dust that when added to water dissolves like an effervescent pill. "In that moment it starts to become a gel, similar to the one used for hair styling, but much stronger and resistant; at the same time, some crystal flakes are formed, these are unwanted sub-products in hardened cement," Rubio said. Due to this, researchers focused on modifying the micro-structure of the cement in order to eliminate crystals and make it completely gel, helping it to absorb solar energy and then return it to the environment as light. By the morning, the building, road, highway or structure that is made out of this new cement can absorb solar energy and emit it during the night for around 12 hours, researchers said.

Source http://timesofindia.indiatimes.com/tech/tech-news/Roads-to-emit-light-with-solar-charged-cement/articleshow/52200527.cms

2. First Frequency Comb of Time-Bin Entangled Qubits Created



New device creates entangled photons that span the traditional telecommunications spectrum, making it appealing for multi-channel quantum communication and more powerful quantum computers.

Quantum mechanics, with its counter-intuitive rules for describing the behaviour of tiny particles like photons and atoms, holds great promise for profound advances in the security and speed of how we communicate and compute. Now an international team of researchers has built a chip that generates multiple frequencies from a robust quantum system that produces time-bin entangled photons. In contrast to other quantum state realizations, entangled photons don't need bulky equipment to keep them in their quantum state, and they can transmit quantum information across long distances. The new device creates entangled photons that span the traditional telecommunications spectrum, making it appealing for multi-channel quantum communication and more powerful quantum computers. The basis of quantum communications and computing lies in qubits, the quantum equivalent of classical bits. Instead of representing a one or a zero, qubits can exhibit an unusual property called superposition to represent both numbers simultaneously. In order to take full advantage of superposition to perform difficult calculations or send information securely, another quantum mechanical property called entanglement enters the picture. Entanglement was famously called "spooky action at a distance" by Albert Einstein. It links particles so that measurements on one instantaneously affect the other. The researchers used photons to realize their qubits and entangled them by sending two short laser pulses through an interferometer, a device that directs light beams along different paths and then recombines them, to generate double pulses. To generate multiple frequencies, researchers sent the pulses through a tiny ring, called a microring resonator. The resonator generates photon pairs on a series of discrete frequencies, using spontaneous form-wave mixing, thus creating a frequency comb. The interferometer the team used has one long arm and one short arm, and when a single photon comes out of the system, it is in a superposition of time states, as if it travelled through both the long arm and the short arm simultaneously. Time-bin entanglement is a particularly robust form of photon entanglement. Photons can also have their polarization entangled, but waveguides and other types of optical equipment may alter polarization states. The researchers at University of Quebec, Canada are one of the first to create photons with multiple frequencies using the same chip. This feature can enable multiplexed and multi-channel quantum communications and increased quantum computation information capacity. They note that the chip could improve quantum key distribution, a process that lets two parties share a secret key to encrypt messages with theoretically unbreakable security. It could also serve as a component of a future quantum computer. "In the future you may have a computer with both quantum and classical capabilities. The quantum part would only be used to solve specific problems that are difficult for classical computers," said the leader of the group that developed the chip. Before quantum computers reach a desktop near you, they need to be scaled down, in terms of size, and scaled up, in terms of computing power. The team is currently working to integrate the lasers, interferometer, and microring resonator of the device into a standard photonic chip, to build logic gates for quantum state manipulation, and to increase the degree of entanglement, which is a measure of the strength of the link between particles.

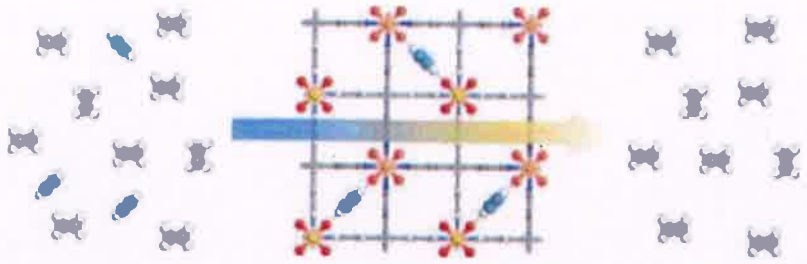
Source https://www.sciencedaily.com/releases/2016/04/160427150627.htm

3. Robot's in-Hand Eye Maps Surroundings, Determines Hand's Location

Before a robot arm can reach into a tight space or pick up a delicate object, the robot needs to know precisely where its hand is. Researchers at Carnegie Mellon University's Robotics Institute have shown that a camera attached to the robot's hand can rapidly create a 3-D model of its environment and also locate the hand within that 3-D world. Doing so with imprecise cameras and wobbly arms in real-time is tough, but the CMU team found they could improve the accuracy of the map by incorporating the arm itself as a sensor, using the angle of its joints to better determine the pose of the camera. This would be important for a number of applications, including inspection tasks, said researchers. Placing a camera or other sensor in the hand of a robot has become feasible as sensors have grown smaller and more power-efficient, a researcher said. That's important, they explained, because robots "usually have heads that consist of a stick with a camera on it." They can't bend over like a person could to get a better view of a work space. But an eye in the hand isn't much good if the robot can't see its hand and doesn't know where its hand is relative to objects in its environment. It's a problem shared with mobile robots that must operate in an unknown environment. A popular solution for mobile robots is called simultaneous localization and mapping, or SLAM, in which the robot pieces together input from sensors such as cameras, laser radars and wheel odometry to create a 3-D map of the new environment and to figure out where the robot is within that 3-D world. "There are several algorithms available to build these detailed worlds, but they require accurate sensors and a ridiculous amount of computation," Srinivasa, a researcher said. Those algorithms often assume that little is known about the pose of the sensors, as might be the case if the camera was handheld, he said. But if the camera is mounted on a robot arm, he added, the geometry of the arm will constrain how it can move. "Automatically tracking the joint angles enables the system to produce a high-quality map even if the camera is moving very fast or if some of the sensor data is missing or misleading," researchers said. The researchers demonstrated their Articulated Robot Motion for SLAM (ARM-SLAM) using a small depth camera attached to a lightweight manipulator arm, the Kinova Mico. In using it to build a 3-D model of a bookshelf, they found that it produced reconstructions equivalent or better to other mapping techniques.

Source https://www.sciencedaily.com/releases/2016/05/160516110416.htm

4. Right Size and Right Chemistry Makes the Right Stuff for Plastics Manufacturing



Ethylene (on left in gray) is usually contaminated with acetylene (blue), which can ruin the process that creates the polyethylene used in most plastic. SIFSIX metal-organic frameworks (center) can capture the acetylene efficiently, leaving pure ethylene (right).

Plastic manufacturing is an energy-intensive process. Now, research performed in part at the National Institute of Standards and Technology (NIST) has revealed a way to reduce the energy demand in one key step of plastic manufacturing by using a class of materials that can filter impurities more efficiently than the conventional manufacturing process. The findings show that materials called metal-organic frameworks (MOFs) can effectively remove the contaminant acetylene from ethylene, the material from which much of the world's plastic is made. The research suggests that filtering out acetylene using MOFs would produce ethylene at the high purity that industry demands while sidestepping the current need to convert acetylene to ethylene via a costly catalytic process. Polyethylene, a pliable material is made by stringing together long chains of ethylene. Worldwide demand for plastic makes ethylene the most widely produced organic compound in the world, with well over 100 million tons of it manufactured each year, largely by refining crude oil. Newly made ethylene is not pure enough to become plastic because the refinement process also creates a substantial amount of acetylene, which can ruin the catalysts that enable ethylene molecules to be strung together. The conventional industrial solution is to convert this undesirable acetylene into ethylene as well, but this step requires the use of palladium, an expensive and rare metal, as a catalyst and consumes a significant amount of energy. The research team, which includes scientists from the NIST Center for Neutron Research (NCNR) found that a family of MOF materials called SIFSIX, discovered in the 1990s, might provide a better alternative for removing the acetylene. MOFs are porous crystals and SIFSIX group gets its name from some of its girders, which are formed from silicon (Si) and six atoms of fluorine (F6). The team found that when they passed ethylene through the MOFs, the fluorine attracted and captured most of the acetylene contaminant, letting the now-purified ethylene to pass unhindered. Varying the size of the pores by changing the length of the girders allowed the MOFs to filter ethylene-containing acetylene in concentrations of anywhere from 1 percent to 50 percent, which are typical in industry. The SIFSIX MOFs set records among adsorbent materials for both selectivity and adsorption capacity and offers a viable alternative to standard industrial practice. They reduced the amount of acetylene in ethylene down to less than 2 parts per million (ppm), which is lower than the 5 ppm that polyethylene manufacturing requires. SIFSIX MOFs are easy to produce, safe to use, and can be reused over and over again. They also have the advantage of being stable, which is not true of all MOFs.

Source https://www.sciencedaily.com/releases/2016/05/160519144548.htm

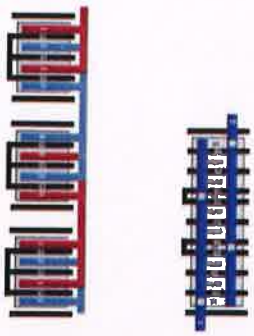
5. A Better Hologram for Fraud Protection and Wearable Optics

New hologram produces 3-D images across different spectrums of light.

Holograms are a ubiquitous part of our lives. They are in our wallets — protecting credit cards, cash and driver's licenses from fraud — in grocery store scanners and biomedical devices. Even though holographic technology has been around for decades, researchers still struggle to make compact holograms more efficient, complex and secure. Researchers at the Harvard John A. Paulson School of Engineering and Applied Sciences have programmed polarization into compact holograms. These holograms use nanostructures that are sensitive to polarization to produce different images depending on the polarization of incident light. This advancement, which works across the spectrum of light, improves anti-fraud holograms as well as those used in entertainment displays. "The novelty in this research is that by using nanotechnology, we've made holograms that are highly efficient, meaning that very little light is lost to create the image," said Federico Capasso, the Robert L. Wallace Professor of Applied Physics and Vinton Hayes Senior Research Fellow in Electrical Engineering. "By using incident polarized light, you can see far a crisper image and can store and retrieve more images. Polarization adds another dimension to holograms that can be used to protect against counterfeiting and in applications like displays." Holograms, like digital photographs, capture a field of light around an object and encode it on a chip. However, photographs only record the intensity of light while holograms also capture the phase of light, which is why holograms appear three-dimensional. "Our holograms work like any other but the image produced depends on the polarization state of the illuminating light, providing an extra degree of freedom in design for versatile applications," said researchers. There are several states of polarization. In linearly polarized light the direction of vibration remains constant while in circularly polarized light it rotates clockwise or counterclockwise. The direction of rotation is the chirality. The team built silicon nanostructured patterns on a glass substrate, which act as superpixels. Each superpixel responds to a certain polarization state of the incident light. Even more information can be encoded in the hologram by designing and arranging the nanofins to respond differently to the chirality of the polarized incident light. "Being able to encode chirality can have important applications in information security such as anti-counterfeiting," said researchers. "For example, chiral holograms can be made to display a sequence of certain images only when illuminated with light of specific polarization not known to the forger." "By using different nanofin designs in the future, one could store and retrieve far more images by employing light with many states of polarization," they said. Because this system is compact, it has application in portable projectors, 3D movies and wearable optics.

Source https://www.sciencedaily.com/releases/2016/05/160513150533.htm

6. High-Efficiency Power Amplifier Could Bring 5G Cell Phones



This diagram shows the standard layout of transistors in cell phone power amplifiers, at left, and a new highly efficient amplifier design, at right. The new design could help make possible next-generation cell phones, low-cost collision-avoidance radar for cars and lightweight microsatellites for communications.

A new highly efficient power amplifier for electronics could help make possible next-generation cell phones, low-cost collision-avoidance radar for cars and lightweight microsatellites for communications. Fifth-generation, or 5G, mobile devices expected around 2019 will require improved power amplifiers operating at very high frequencies. The new phones will be designed to download and transmit data and videos faster than today's phones, provide better coverage, consume less power and meet the needs of an emerging "Internet of things" in which everyday objects have network connectivity, allowing them to send and receive data. Power amplifiers are needed to transmit signals. Because today's cell phone amplifiers are made of gallium arsenide, they cannot be integrated into the phone's silicon-based technology, called complementary metal-oxide-semiconductor (CMOS). The new amplifier design is CMOS-based, meaning it could allow researchers to integrate the power amplifier with the phone's electronic chip, reducing manufacturing costs and power consumption while boosting performance. "Silicon is much less expensive than gallium arsenide, more reliable and has a longer lifespan, and if you have everything on one chip it's also easier to test and maintain," said researchers at Purdue University. "We have developed the highest efficiency CMOS power amplifier in the frequency range needed for 5G cell phones and next-generation radars." The amplifier achieves an efficiency of 40 percent, which is comparable to amplifiers made of gallium arsenide. The researchers created the new type of amplifier using a high-performance type of CMOS technology called silicon on insulator (SOI). The new amplifier design has several silicon transistors stacked together and reduces the number of metal interconnections normally needed between transistors, reducing "parasitic capacitance," which hinders performance and can lead to damage to electronic circuits. "We have merged transistors so we are using less metallization around the device, and that way we have reduced the capacitance and can achieve higher efficiencies," they said. "We are trying to eliminate metallization between transistors." The new amplifiers could bring low-cost collision-avoidance radars for cars and electronics for lightweight communications microsatellites. The CMOS amplifiers could allow researchers to design microsatellites that are one-hundredth the weight of today's technology.

Source https://www.sciencedaily.com/releases/2016/05/160517191957.htm

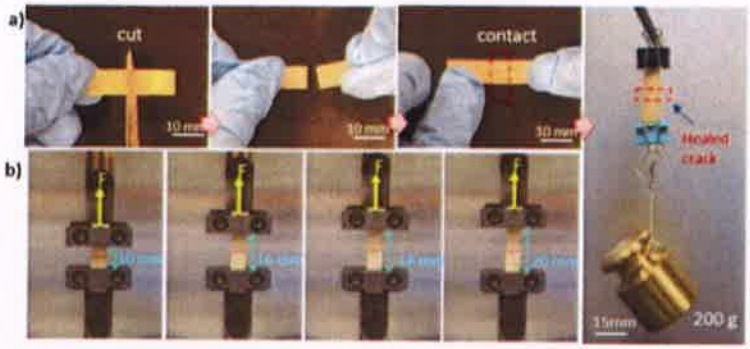
7. ISRO Launches RLV-TD from Sriharikota, First Step towards Reusable Space Shuttle Made In India

The RLV-TD lifts off in Sriharikota. After successfully surviving high temperatures of re-entry with the help of its TPS, RLV-TD successfully glided down to the defined landing spot over Bay of Bengal, at a distance of about 450 km from Sriharikota.

The Indian Space Research Organization last month, joined the race to develop a space vehicle that can fly numerous times into space like aeroplanes by successfully conducting the maiden test flight of a Reusable Launch Vehicle-Technology Demonstrator at the Satish Dhawan Space Centre at Sriharikota in Andhra Pradesh. "Today, May 23, 2016 ISRO successfully flight tested India's first winged body aerospace vehicle operating in hypersonic flight regime," ISRO said in an official statement after the test flight. In the experimental mission an HS9 solid rocket booster lifted the RLV-TD from its launch pad at 7 am to a height of 56 km where the RLV TD separated from the rocket and climbed to a height of 65 km before automatically steering itself back for a landing in the Bay of Bengal some 450 km away from the Sriharikota space station. "After successfully surviving the high temperatures of re-entry with the help of its Thermal Protection System (TPS), RLV-TD successfully glided down to the defined landing spot thereby fulfilling its mission objectives," ISRO said in its statement after the flight test. "The vehicle's navigation, guidance and control system accurately steered the vehicle for safe descent," ISRO said. The total flight duration from launch to landing of this mission of the RLV-TD was 770 seconds. The RLV was tracked during its flight from ground stations at Sriharikota and a ship terminal. "In this flight critical technologies such as autonomous navigation, guidance and control, reusable thermal protection system and re-entry mission management have been successfully validated," ISRO said. The flight test was supported by the Indian coast guard and the National Institute of Ocean Technology (NIOT) for mid sea wind measurements and shipborne telemetry. The RLV -TD that ISRO flew at Sriharikota is the first step in an Indian effort to develop a Two Stage To Orbit (TSTO) fully reusable vehicle. The hypersonic flight experiment (HEX) will be followed by a landing experiment (LEX), a return flight experiment (REX) and a scramjet propulsion experiment (SPEX) in the coming days. Though manned space flight is the ultimate goal of RLVs the major advantage of development of an RLV is the reduction in cost of space launches and space travel itself. "Nearly 80 to 87 per cent of the cost in a space launch vehicle goes into the structure of the vehicle. The costs of propellants is minimal in comparison. By using RLVs the cost of a launch can be reduced by nearly 80 per cent from the present cost," says the VSSC director Dr K Sivan.

Source http://indianexpress.com/article/technology/science/rlv-td-indias-first-reusable-space-shuttle-launched-from-sriharikota/

8. Self-Healing, Flexible Electronic Material Restores Functions after Many Breaks



Electronic materials have been a major stumbling block for the advance of flexible electronics because existing materials do not function well after breaking and healing. A new electronic material created by an international team, however, can heal all its functions automatically even after breaking multiple times. This material could improve the durability of wearable electronics. "Wearable and bendable electronics are subject to mechanical deformation over time, which could destroy or break them," said Qing Wang, professor of materials science and engineering, Penn State. "We wanted to find an electronic material that would repair itself to restore all of its functionality, and do so after multiple breaks." Self-healable materials are those that, after withstanding physical deformation such as being cut in half, naturally repair themselves with little to no external influence. In the past, researchers have been able to create self-healable materials that can restore one function after breaking, but restoring a suite of functions is critical for creating effective wearable electronics. For example, if a dielectric material retains its electrical resistivity after self-healing but not its thermal conductivity, that could put electronics at risk of overheating. The material that Wang and his team created restores all properties needed for use as a dielectric in wearable electronics -- mechanical strength, breakdown strength to protect against surges, electrical resistivity, thermal conductivity and dielectric, or insulating, properties. Most self-healable materials are soft or "gum-like," said Wang, but the material he and his colleagues created is very tough in comparison. His team added boron nitride nanosheets to a base material of plastic polymer. Like graphene, boron nitride nanosheets are two dimensional, but instead of conducting electricity like graphene they resist and insulate against it. "Most research into self-healable electronic materials has focused on electrical conductivity but dielectrics have been overlooked," said Wang. "We need conducting elements in circuits but we also need insulation and protection for microelectronics." The material is able to self-heal because boron nitride nanosheets connect to one another with hydrogen bonding groups functionalized onto their surface. When two pieces are placed in close proximity, the electrostatic attraction naturally occurring between both bonding elements draws them close together. When the hydrogen bond is restored, the two pieces are "healed." Depending on the percentage of boron nitride nanosheets added to the polymer, this self-healing may require additional heat or pressure, but some forms of the new material can self-heal at room temperature when placed next to each other. Unlike other healable materials that use hydrogen bonds, boron nitride nanosheets are impermeable to moisture. This means that devices using this dielectric material can operate effectively within high humidity contexts. "This is the first time that a self-healable material has been created that can restore multiple properties over multiple breaks, and we see this being useful across many applications," said Wang.

Source https://www.sciencedaily.com/releases/2016/05/160516125349.htm

Energy Engineering

9. Under Pressure: New Technique Could Make Large, Flexible Solar Panels More Feasible

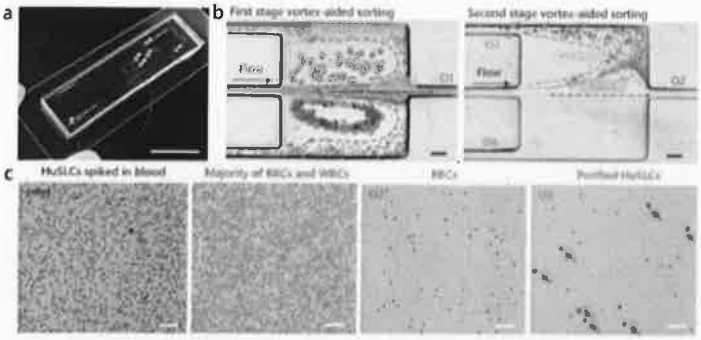
High-pressure deposition inside rolled-up, flexible substrates allows for extremely large-area, uniform-thickness, hydrogenated, amorphous silicon films that are useful for applications such as flat-panel displays and solar cells.

A new, high-pressure technique may allow the production of huge sheets of thin-film silicon semiconductors at low temperatures in simple reactors at a fraction of the size and cost of current technology. "We have developed a new, high-pressure, plasma-free approach to creating large-area, thin-film semiconductors," said John Badding, professor at Penn State and the leader of the research team. "By putting the process under high pressure, our new technique could make it less expensive and easier to create the large, flexible semiconductors that are used in flat-panel monitors and solar cells and are the second most commercially important semiconductors." Thin-film silicon semiconductors typically are made by the process of chemical vapor deposition, in which silane undergoes a chemical reaction to deposit the silicon and hydrogen atoms in a thin layer to coat a surface. To create a functioning semiconductor, the chemical reaction that deposits the silicon onto the surface must happen at a low enough temperature so that the hydrogen atoms are incorporated into the coating. With current technology, this low temperature is achieved by creating plasma in a large volume of gas at low pressure. Massive and expensive reactors so large that they are difficult to ship by air are needed to generate the plasma and to accommodate the large volume of gas required. "With our new high-pressure chemistry technique, we can create low-temperature reactions in much smaller spaces and with a much smaller volume of gas," said Badding. "The reduced space necessary allows us, for the first time, to create semiconductors on multiple, stacked surfaces simultaneously, rather than on just a single surface. To maximize the surface area, rolled-up flexible surfaces can be used in a very simple and far more compact reactor. The area of the resulting rolled-up semiconducting material could, upon further development, approach or even exceed a square kilometer."

Source https://www.sciencedaily.com/releases/2016/05/160516091551.htm

Interdisciplinary Engineering and Special Fields

10. Integrated Inertial Microfluidic Vortex Sorter



Sorting and purification of human cancer stem-like cells (HuSLCs) from human blood using the novel inertial microfluidic vortex sorter. (a) Photograph of the microfluidic device. (b) Microscopic bright-field images showing the double sorting and purification of HuSCLs from human red blood cells (RBC) using the two microvortex chambers. (c) Microscopic bright-field images illustrating samples before sorting (inlet) and after sorting (outlets O1,O2,O3) indicating successful purification of HuSLCs from outlet 3 (O3).

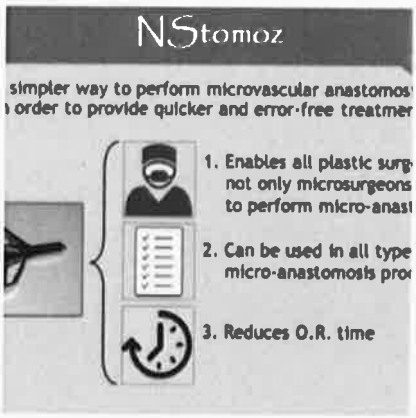
A team of researchers from University of Cincinnati have developed a novel microfluidic device, which combines the inertial effect of fluid and microscale vortices generated in microchambers, to achieve simultaneous double sorting of rare target cells and removal of background cells. Sorting and purification of target cells from complex cellular samples is a critical sample preparation step in cell biology research and clinical diagnostics. This task becomes even more challenging for samples containing orders of magnitude larger number of background cells and only a small fraction of target cells, because sorting of such samples not only requires efficient extraction of the target cells but also highly efficient removal of the background cells. The device presented in this work accomplished this challenging task by enabling double sorting functionality that can extract large target cells from background cells in a continuous and automatic fashion. "Microfluidics has been an enabling technology in recent two decades. The development in this field led to a large numbers of fascinating tools for a wide range of applications, including molecular biology, cell biology, and clinical diagnostics. Our microfluidic device is able to sort cells label-free, based on their size, continuously and automatically. The unique feature of this device is that it can isolate and extract larger target cells, while eliminating nearly all non-target cells and yielding highly purified cells of interest. This purified cellular sample is beneficial for downstream biomedical research and diagnostics," say researchers. Although previous microfluidic devices demonstrate sorting of cells with efficiency >95%, it is often insufficient to obtain highly purified target cells if sample contains non-target cells in concentrations multiple orders of magnitude higher than that of the target cells. The microfluidic device in this work introduces an integrated vortex-based inertial microfluidic chip for continuous double sorting and purification of biomicroparticles with high efficiency and purity. The device first uses an inertial effect of fluid in microscale channels to focus fast-flowing cells into highly ordered streaks. Downstream, the first pair of microchambers generates microscale vortices and as cells pass through, the larger target cells are extracted and exit through the two outlets at the corners of the chamber. The smaller background cells elute from the middle outlet. To further remove the remaining background cells and purify large target cells, the two target-cell outlets feed into to a second pair of microchambers to enable the double sorting function that yields highly purified target cell product. To demonstrate the feasibility of sorting of rare cells as well as efficient removal of a large number of background cells, a small number of human cancer stem-like cells (HuSLCs) was spiked into human blood. The device successfully isolated the HuSLCs, while removing >99.97% of the non-target RBCs. Cellular samples contain cells of different size. Thus, flexibility of tuning the sorting and extraction cutoffs is critical for maintaining performance. For most of today's microfluidic devices, the sorting cutoff is modified by re-designing and re-fabricating the device. This leads to longer development time, higher cost, and possibly delays in processing of time-sensitive biological samples. In this device, researchers were able to tune the sorting cutoff diameter by simply changing the input flow rate or by modifying the fluidic resistance without the burden of re-designing and re-fabricating the entire device. The team is working further towards optimizing the device to accomplish more challenging cell sorting tasks, such as isolation of the extremely rare circulating tumour cells (CTC) from cancer patients' blood. In addition, they are also working to expand the functionalities of this vortex sorting platform.

Source https://www.sciencedaily.com/releases/2016/05/160520110352.htm

Engineering Innovation in India
Gandhi Young Technological Innovation (GYTI) 2016 Awards

The Gandhi Young Technological Innovation (GYTI) 2016 Awards were conferred on 13th March 2016 at Rashtrapati Bhavan. Brief details of two award winning projects are given below.

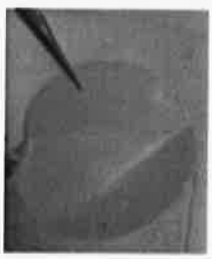
- **Nstomoz - Vascular Anastomosis Assist Device**



Innovator: Anand Parikh **Guide:** Prof V Balasubramanian; Dr V B Narayanamurthy; **College:** Indian Institute of Technology Madras

Connecting vascular tissues is a common practice in many fields of surgeries. For the tissue to survive, its donor vessels need to be connected to the corresponding recipient blood vessels. This process is known as vascular anastomosis. Vascular anastomosis is carried out in more than 3.5 million procedures worldwide every year, including all bypass surgeries, all aneurysmectomies, all solid organ transplants and various types of microsurgeries. This number is increasing at a phenomenal rate with increase in indications such as road traffic accidents, cancers, and a variety of lifestyle diseases. Presented here is a patented anastomotic assist device to enable surgeons of all specialties to perform anastomosis faster, safer and with an easier learning curve. The three key challenges in vascular anastomosis – zero margin for error, steep learning curve, and long procedure time; are addressed by our device. It was identified that the root cause of difficulty in vascular anastomosis lies in the limitation of its gold standard device, vascular clamps. application of vascular clamps, while preventing blood from flowing into the field of surgery causes collapse of the blood vessel lumen, thus creating a bottleneck for manipulating and suturing delicate vasculature. This novel technology keeps the lumen open to the surgeon's view while simultaneously clamping the blood vessel. This greatly de-skills the process by allowing the surgeon to suture with minimal manipulation of the vessel, thereby reducing the possibility of vessel damage and saving pricey OT time lost during manipulation. Suturing, the current gold standard for microanastomosis, is a highly efficient procedure, if performed correctly. Yet, many innovations around vascular anastomosis have attempted to eliminate it. These concepts have not gained traction in practice as they are expensive, they introduce foreign substances, have limited application and their method of usage drastically differs from the gold standard. This invention has leveraged the efficiency of sutures and eliminated its biggest flaw, in order to create a reusable, sterilizable, easy to use alternative to vascular clamps whose operation is majorly aligned with the standard technique.

- **Green Flexible Conducting Paper From Edible Bacteria Derived 3d Nanocellulose Matrix and Polyaniline**



Innovator: Divya Anand, **Guide:** Dr. Mudrika Khandelwal, **College :** Indian Institute of Technology Hyderabad

Development of new greener material for conducting paper is sought for applications such as security paper, actuators, and anti-static packaging. It is required that the material for these applications possess low density and good mechanical integrity. This work presents a way to produce bacterial nanocellulose (BC) - polyaniline (pani) nanocomposites by in situ polymerization in suspension of cellulose nanowhiskers. The advantages of using BC are its ultrafine network structure, sufficient porosity, high purity and crystallinity, good mechanical properties, great water holding capability and low environmental impact. The BC/pani composites formed by optimized synthesis of pani within cellulose nanowhiskers possess good electrical conductivity in addition to excellent mechanical properties and flexibility.

Source http://gyti.techpedia.in