INDIAN NATIONAL ACADEMY OF ENGINEERING

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From the Editor's Desk

Optimism and Grand Challenges

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ACADEMY ACTIVITIES

Academy Announcements

Recent Dispatches from INAE Secretariat

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- Nominations have been invited for INAE Young Engineer Award 2016 and Innovative Student Projects Award 2016. The last date for receipt of nominations for INAE Young Engineer Award is May 31, 2016 and for Innovative Student Projects Award is July 7, 2016.
- Nominations have also been invited from the Fellowship for Life Time Contribution Award in Engineering; Prof Jai Krishna and Prof SN Mitra Memorial Awards and Outstanding Teachers Award. The last date for receipt of nominations is May 15, 2016.

The nominations for the above are requested from the Fellowship. 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 dates.

Creation of Data for INAE Expert Pool

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Creation of Data for INAE Expert Pool

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 importance. A letter from Dr BN Suresh, President, INAE had been forwarded recently to all Fellows and Young Associates who have not upload their particulars on the link for the INAE Expert Pool. 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 .

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 Sept 1-3, 2016 with Prof. Bhaskar Ramamurthi, Director, IIT Madras as the Chair 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 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. The following sub-themes on Smart Cities are planned: E-Governance; Water & Sanitation; Healthcare; Transportation & Infrastructure and Energy.

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

National Competition on Innovations in Manufacturing Practices - 2016 (IMP-2016)

IIT Kanpur, INAE along with the INAE Kanpur Local Chapter organized the national level competition on "**Innovation in Manufacturing Practices 2016"** (IMP-2016) to provide a platform to display and showcase the talent of bright engineering students in design and manufacturing. The event was organized during TECHKRITI 2016 held at IIT Kanpur from 3rd March to 6th March, 2016. As part of the competition, a team had to design an effective and innovative model and give a final working shape as a product/prototype. Student entries were invited both at under graduate and post graduate level; from different engineering colleges /institutions across the country. The students had to submit an abstract, project description and design and working principle in the form of video. There were about 100 entries at Undergraduate and 16 at Postgraduate level. First, these entries were screened by a committee of Fellows of INAE and faculty members of IIT Kanpur, who shortlisted eight teams for the final presentation at under graduate level and none in post graduate level. IMP 2016 final evaluation was conducted on 4th March 2016 with a small inaugural function presided over by the Prof Indranil Manna, Director, IIT Kanpur, in which INAE Kanpur Local Chapter members, Faculty members, students from IIT Kanpur and engineering colleges across the country, staff members and media personnel participated. A committee headed by Prof. Kallol Mondal evaluated the six under graduate projects.

The results of the evaluation are given below.

1st prize	Green technocrats – generating electricity from to and fro movement of big Hoarding by using wind energies
2nd prize	Quantum mechanical parts – Integration of multiple motors and generating power in a more efficient manner.
3rd prize	It was shared with Robo music and internal nano polishing

The prizes were distributed during the Valedictory Session held on the same day. A Feedback was also taken from the participants regarding the competition.

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

The world is experiencing technology and policy paradigm changes to match the challenges of sustainability. There is a growing awareness that engineering graduates need mentorship to excel in soft and engineering skills to compete in the present scenario and meet the demands of the country and the world. The role of the industry and the academia has always been understood to be complementary and crucial as Industry is responsible for producing the products and wealth; the academia supplies the necessary back up in terms of the technocrats and the professionals who run the industry. Recent times have seen renewed efforts to enhance industry-academia –research interactions to build up synergies and address the complementary issues through strengthening interfaces and mechanisms of implementation. Cohesive approach to harness Academia-Research-Industry expertise is the key to imparting relevant and right knowledge to young minds. 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 BC Pai CSIR Emeritus Scientist, CSIR, National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram, Kerala	Government college of Engineering, Tirunelveli Mar 10-11,2016	As per the feedback from engineering college the Industry Expert has delivered lectures on "Basics of Tribology and Materials Developments for Tribiological Applications"; "Basics of Corrosion and Prevention Methods" and "Processing and Properties of Ultrafine Grained and Nanostructured Materials for Engineering Applications". He also gave inputs for guiding student projects. His suggestions on curriculum are being proposed to the syllabus framing committee. The queries of PG Students and research scholars were also addressed satisfactorily and one technical paper has been published.
Mr S Madivaanan, Formerly Additional Director, CVRDE, Chennai	Velammal Engineering College, Chennai Feb 29, 2016	The industry expert delivered lecture on "Application of Drones in Defence". According to the feedback received from the engineering college faculty coordinator, this scheme provides opportunity to interact with eminent Industry Experts. The rich experience gained by the expert from industry is shared with both faculty and students. This helps in getting wider depth in the knowledge being imparted to students and helps the budding engineers to understand industry requirements and applications.

International Conferences/Seminars being organized by IITs/other Institutions

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

Honours and Awards

1	Dr TSR Prasada Rao, Chairman, Sarasi Jam Technologies, New Delhi and Formerly Director, Indian Institute of Petroleum, Dehradun was conferred the prestigious "Energy and Environment Foundation Global Excellence Award - 2016 in Petroleum Energy Sector" on 15th February 2016 at New Delhi, by Hon'ble Mr. Anil Razdan, Former Secretary Power, Government of India and Chairman Energy and Environment Foundation.

News of Fellows

1	Prof Ganti Prasad Rao, President and CEO, Inventive Pathways-Management Consultancy, Abu Dhabi has edited two books under the CRC Book Series –"Engineering Systems and Sustainability" on "Multi - Stage Flash Desalination" and "Nonlinear Stochastic Control and Filtering" published by CRC Press.

International Conference on Emerging Technologies in Civil Engineering, Architecture and Environmental Engineering for Global Sustainability (CEAEGS- 2016) on May 1, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=167367

International Conference on Recent Advances in Electrical, Electronics and Communication Technology (ECT – 2016) on May 8, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=167378

International Conference on Advances in Biomedical Engineering, Cancer Biology, Stem Cells, Bioinformatics and Applied Biotechnology (ABECBAB-2016) on May 14, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=167616

A Journey from a Remote Village to Capital of India

SHIKARIPUR SREENIVASA MURTHY

I was born in a Karnataka village in 1946, a few months before India's Independence. My father was a primary school teacher and mother a highly religious house-wife. My father's first appointment was at a tiny village Hosahalli on the banks of Tunga river at a distance of 6 km from the District centre of Shivamogga. It had less than 30 houses and the situation has not changed till now. The village Mattur situated on the other bank of the river was subsequently known as the "Sanskrit" village as most of the villagers knew how to speak Sanskrit. The twin village complex of 'Hosahalli-Mattur' was mostly inhabited by 'Sanketi- Brahmins' well versed in Vedas, Sanskrit and Music. My father and our family received considerable affection and respect from these villagers till date and I found this association very rewarding. The place is unique with nearly 100% literacy and most of the families have siblings abroad mostly in USA being active members of NASA (North American Sanketi Association). Hosahalli school was run in a temple and my father was responsible for constructing a separate school building by impressing the district educational officer. I spent my pre-school life in this village and remember little about it except narration by elders. It seems I was a chubby social kid attracted to neighborhood feeling at 'home' in all the nearby houses making my mother to search for me during lunchtime.

Then my father underwent a 'Basic Teacher Training' based on the concept of Mahatma Gandhi at Devanahalli near the present Bengaluru Airport. The idea is to teach in schools skills such as spinning, operating Charaka, horticulture etc apart from 3R's. After this training my father had to be posted to select 'Basic Training' schools. Thus he was shifted to village Belagutti in the same district where I joined for my primary school and learnt spinning, gardening etc. It was like any other village with little facilities (no electricity) and infested with snakes.

There was a breakthrough in 1954 when my father succeeded in getting a transfer to his native place Shikaripur, a major Taluka town in the district. Thus I had opportunity to study in a bigger town, with population of about 10,000, which had electricity although my house was not electrified making me to study under kerosene lamps. Since I was doing well in studies I got 'double' promotion and jumped from 3rd to 5th standard at the Govt. Middle School there. After completing the middle school I joined the local Municipal High School towards matriculation. I stood first in each class throughout this schooling period and earned admiration and affection from my teachers. Although I studied in government schools, I had many good and inspiring teachers, which is in contrast to impressions of govt. schools today. I had excellent teachers in Mathematics and Sanskrit. I studied in Kannada medium till matriculation with no subject deficiency although our English communication was weak. Based on my experience, I see merit in teaching in mother tongue in initial stages and shifting to English medium in higher education, which is manageable. I stood first for the school in the Matriculation examination in 1961 with 83% marks and 22nd rank for the then state of Mysore which was considered a proud achievement for a small town boy. Icing on the cake was my scoring 100% in both general and optional Mathematics. This was a proud and happy event in my life that was to decide my future.

Due to my above merit, my teachers and well wishers advised my father to admit me to a good college in Bangalore (present Bengaluru) for pre-university and not to the nearby college in Shimoga which was not rated high. My father took me to Bangalore and I was easily selected for

the National College, which was then rated as the best college in the city. This was my first visit to Bangalore (to any city for that matter) that was away from my Shikaripur town by 350 km, and I was simply bewildered by the vast difference in this city ambience compared to where I came from. While I could easily get admission to the best college in the city I had no place to stay. Monthly charges of about Rs.60/- in most local Hostels were expensive for my father to afford with his monthly salary of about Rs.100/- as a teacher. However I was extremely lucky to get admission in Sri Ramakrishna Students' Home (normally addressed as 'Home') that provided free boarding and lodging to its inmates. This is a unique institution of Bangalore inspired by Ramakrishna Mission, not directly administered by them, that has been helping merited and needy students since 1919, mostly supported and managed by old boarders. I shifted to English medium in the college and faced initial hick ups. I envied my city-bred classmates who spoke fluent English while I was fumbling to speak even two sentences. Slowly I picked up and tried to catch up with them. But my Kannada was better than theirs and I won prizes in Kannada debates. National college had good teachers and I learnt all I needed in the classroom as 'coaching centres' were unheard of those days with private tuition resorted by weak students. Well known Gandhian Dr. H Narasimhaiah (a Padmashree awardee and later VC of Bangalore University) took over as Principal of the college that year as he taught us Physics. I was deeply impressed by his personality as he was a simple, dedicated and inspiring academic always wearing white Khadi shirt, lungi and cap. He lived in a room in the students' hostel and slept on the floor using a mat and a bed.

At this juncture a benevolent decision of Govt. of India turned out to be a great boon to me that steered my future growth. Dr. KL Shrimali, then education minister introduced a new National Merit Scholarship for teachers' children from that year (1961) based on the Matriculation performance. Fortunately I stood second in merit among teachers' children in Karnataka who took matric examination that year and thus bagged this merit scholarship. For the first time I saw my name appearing in Newspapers as the list of candidates for this scholarship for the state was published in the press. My happiness knew no bounds as it was a great relief to get over financial problems and pursue my studies unhindered. In retrospect, I consider two factors that crucially decided what I am today- selection in Ramakrishna Students' Home and getting this National Merit scholarship. I am ever grateful to my country and society for helping me at this critical juncture to pursue my studies. The monthly scholarship amount of Rs.50 and Rs.100 during pre university and degree classes respectively worked like oxygen for my education.

I passed pre-university in 1962 in first class with high merit to get admission in BMS College of Engineering (BMSCE) for the five-year integrated engineering degree program. There were only two engineering colleges in Bangalore then against over 100 today. Admissions then were purely on performance in pre-university with no entrance tests and associated coaching. I realized that self-study was more effective than class room teaching although we had quite a few good teachers. With examination oriented education emphasized in colleges affiliated to universities there was little scope for innovation. Unfortunately the situation is no better even today. But we studied text books cover to cover and solved almost all numerical problems with great excitement. The first three years were common after which we branched out. I chose electrical engineering (EE) in which I specialized in last two years. BMSCE had good EE faculty and lab. I was also active in co-curricular and extra-curricular activities. I won prizes in inter college Kannada and English debates, contributed to literary activities such as poems and articles, took part in plays. I was secretary of electrical engineering society. Since we had only one annual examination to face we had enough time to indulge in such activities. I found the all-India tour in the final year a great experience in knowing India. This truly expanded my horizon to appreciate the variety of our country.

'Home' and Ramakrishna Mission (RKM) molded my personality in those teenage years. Hard work, dedication, discipline, integrity, self reliance were the traits instilled in me by these great institutions. I learnt that there was no short cut to success and there was no substitute to hard

work and dedication. The six years I spent in 'Home' (1961-67) was memorable and pages can be written on this unique experience. It was totally managed by the student inmates under the direction of the hon. Secretary with only a cook and a utensil cleaner being paid staff. Housekeeping including toilet cleaning was done by students, which made us to recognize dignity of labor the value I still relish. This made us to survive in any part of the world as we were trained to take care of our needs. My association with RKM has stood the test of time, as Swami Vivekanada is my prime role model. The three-week summer retreat on value education I attended in Mysore Ashram in 1966 steered by Swami Harshanandaji, present Head of Bangalore Ashram, greatly influenced my life as regards spirituality, human values and ethics. The inspiring lectures by the well-known Swami Ranganathanandaji, who subsequently rose to become the president of the Mission, greatly influenced my thoughts. The spiritual universal preaching of Vivekananda devoid of dogmas and superstitions can truly guide ones life to fulfillment. I am convinced that 'value education' must be integral to any education scheme. This conviction made me to be associated in later years with the value education centre of IIT Delhi as Faculty and organize relevant activities.

Another critical and happy turning point in my life was the announcement of the result of my final year examination, which declared that I obtained 9th Rank to the university for the B.E. degree in Electrical Engineering (EE) in 1967. This distinction made me proud; my name appeared in Newspapers as first ten ranks were announced and I kept it as a souvenir.

National economy was not as flourishing as it is today with tight job market and non-existent campus recruitments even to the brightest needing one had to strive hard for future career. With my interest in higher studies I applied for Masters program in IITs and received interview calls from IIT Bombay and Kanpur. I took a train from Bangalore to Mumbai on the way to Kanpur. Dr. KVV Murthy and Dr. K Shankar of EE department of IITB, being my past contacts, provided wonderful hospitality and mentored me on what course to choose. I was selected to the M.Tech program in Energetics and advised by my above friends to go for this choice due to excellent faculty that included Dr KC Mukherjee and Dr RE Bedford. I did not proceed to Kanpur and elected to stick to IITB for M Tech. Thus I was attracted to the strong and great magnet of IIT Family whose association I cherish till date. By this experience I could clearly identify the distinct improved quality of IITs over university affiliated engineering colleges where I came from. Innovation and open-ended teaching learning are the hallmarks of IITs. Dr. Bedford was an outstanding teacher and an excellent human being who inspired me immensely. I had the privilege of doing my M Tech thesis under his guidance to complete my post graduation in 1969.I continued to be in close contact with him till his end. The monthly scholarship of Rs.250/- at IITB was a luxury and life in Hotel-I was cozy compared to deprivation of under-graduate life resulting in my putting on weight.

Then I joined for my first job as a Lecturer on 5th Sept.1969 in a grade of Rs.400-950 in BITS, Pilani, a serene campus. Thus I moved further north to a harsh climate of extreme Rajasthan weather. Prof. I J Nagareth was a dedicated teacher I met there, who has penned several good quality books. I too wanted to be a good teacher and to make my class-room delivery interesting and effective. I referred to the MIT book on effective teaching and tried to follow its tips. This was a good pedagogic effort I would advise to all those joining teaching profession.

I had immense desire to pursue for Ph.D, and BITS then was not found very suitable, with IITs being preferred destinations. I applied for Lecturer's job in IIT Delhi and was called for interview. Based on my good interview performance I learnt that the committee was inclined to consider me for Associate Lecturer (AL) position on contract so that I could also work for my doctorate. I took courage to write a letter to Prof. C S Jha the senior-most professor and first Indian head of EE deptt. of IITD (and later to become Director of IIT Kharagpur, VC of BHU, educational advisor to GoI and founder fellow of INAE) as his area of specialization was of my research interest to take me as AL. I received a quick but negative reply from him that disappointed me. But I had a

great and pleasant surprise after a few weeks when I received another letter from Prof. Jha that IITD was prepared to take me as AL in EE deptt. That was one of my happiest days and a major turning point in my professional career.

I joined IITD as a faculty member on 2nd Nov.1970 that facilitated me to engage in both teaching and research. I was back to IIT fold and registered for my Ph.D. next day under the guidance of Prof. Jha to work on "Generalized Rotating Field Theory of Electric Machine", the topic pioneered by him with highly cited classical papers. While being a Lecturer I secured my Ph.D in 1974 and promoted as Asst. Professor in 1975. As an outcome of this PhD work I published my first classical and highly cited paper on "general rotating field theory of asymmetrical machines' in the reputed Proc. IEE published from UK. This paper is even referred in text books today.

EE Department of IITD had inspirational teachers and researchers such as CS Jha, PV Indiresan, SC Dutta Roy, AK Mahalanobis, PS Satsangi and VS Rajamani who built the department from scratch and guided young faculty like me as role models. They grew to become National/international figures with great contributions. They instilled special values and procedures in the department. According to one 'ranking' recently, this department was ranked first in India and 50th in the World among EE departments that must be attributed to above values. There was no hierarchy and a seniormost professor was treated equal to a juniormost lecturer so that all faculty felt they owned the department. Faculty selection was open, transparent, informal and strictly on merit. Any one can suggest a bright candidate for possible induction. A faculty would be inducted in any area provided one is excellent irrespective of the need in the department, the philosophy being that an excellent faculty would academically contribute to glorify the institute. On the contrary a sub-standard faculty would not be inducted although there is need in that area, as he/she may ultimately be a drag.

'Seniority' has no place in IITs (even in IISc) and one is chosen for a position based on suitability and interest. This is the unique feature that has made these institutions great and others in the country rated lower. 'Flexibility of cadre' practiced in IITs is a great boon so that number in any faculty cadre can be altered to reward/promote a good candidate. Same is recently introduced in NITs which would definitely impact them positively. If any institution or university aspire to move to higher level, above concepts/values must be introduced.

I had the first opportunity to visit abroad when I was deputed in 1975 by IITD to UK under the IITD-UK collaboration arrangement and spend with Dr J E Brown of University of Newcastle upon Tyne. Coordination of the visit by British Council was excellent. Incidentally Dr Brown was the Ph D supervisor of Prof Jha at U of Bristol. My working with Dr Brown on "Capacitor self excited braking of Induction Motors' was truly exciting as he was a perfectionist and our brainstorming meetings led to new fundamental concepts of non-linear behavior of such machines leading to classical publications later. I visited the universities of Loughborough, Bristol, Imperial college, Aberdeen, Liverpool, Glasgow, UMIST apart from a few leading electrical industries. Thus I had the first hand experience of working of British universities which were rated superior to Indian counterparts including IITs. Integrity, time management, good governance and discipline make their education superior to ours. We have lot to emulate to make our higher education comparable to global levels.

I returned to IITD in 1976 and pursued my interest in teaching, research, curriculum and lab development. I am a strong believer in close Industry-Academia interaction and wanted our activities to be of interest to Industry. Mr S G Ramachandra Vice President Kirloskar Electric Co (KEC) showed special interest in me and encouraged my interest in industry interaction. I took a major consultancy project for KEC on "Magnetic Noise in Induction Motors" and successfully

developed a design based noise prediction method. During this period I received the President of India Prize for the best research Paper published in the Journal of Institution of Engineers (India).

Based on my research in UK, I initiated a new research area on "Self Excited Induction Generators" (SEIG) and I am proud to say that based on my work supported by my colleagues guided by me, IITD today is globally the strongest centre on R&D in SEIG with large number of papers, student theses, sponsored projects and patents. My first PhD students (Bhim Singh and AK Tandon) registered with me and did commendable work in the above areas; - I am happy that both of them have great accomplishments in their career.

Based on my academic contributions I was promoted as Associate Professor (in Professor's scale) in 1980. I visited University of Calgary in Canada during 1980-82 under sabbatical leave at the invitation of OP Mallik and GJ Berg that gave me a unique opportunity to undertake new research in a western university ambience with distinctly superior facilities compared to IITs. My research there led to many classical highly cited papers in international journals. Significant ones are on "instantaneous symmetrical components and operational equivalent circuits of induction motors" and "Analysis of Self Excited Induction Generators (SEIG)". My paper on SEIG published in Proc.IEE in 1982 has very high citation index and referred till date. I got the initial experience of presenting my papers in reputed IEEE international conferences in New York and Orlando and meet my peers.

On return to IIT I pursued my research in SEIG. I proposed a new Master's program in "Power Electronics, Electric Machines and Drives" (PEEMD) which was started in 1987 after a rigorous review by expert committees and internal boards. This has become a very popular program conducted through industry interface with several post-graduates in high positions in academia and Industry. IITs have great academic autonomy to start any academic program which is an outcome of rigorous internal and external discussions. We need to respect this autonomy without interference by external regulatory bodies, to maintain their standards and be forward looking.

I was confirmed as Professor in 1983, perhaps one of the youngest to be rewarded with this post during that period. Since I superannuated from IITD in 2012, I served as professor for nearly 30 years.

During 1985-86, I was invited by Kirloskar Electric Co (KEC), Bengaluru to work in their R&D unit as a consultant and to guide them on new industrially relevant research. I focused on 'Wind Electric Generators' (WEG) and 1- phase SEIG for portable gen-sets. I developed the first indigenous 55 kW Induction generator which was built and installed successfully installed in the field for Wind Power. The novel 1- phase SEIG is a unique invention of mine, which has led to several patents and papers with applications in renewable energy based off-grid generation. The area is still researched today at IITD. My visit to KEC gave me a unique industrial experience to know in close quarters the industrial problems and processes. It is my strong view that academia must be encouraged to make such industrial visits that should form a prime activity to promote industry-academia interaction so that teachers may sensitize students on industry in classrooms. Faculty reward system must encourage such visits.

During the above period I taught a course in each semester at IISc as adjunct professor apart from undertaking joint project of relevance to KEC with a colleague in EE department that led to a quality publication.

In 1990, I was invited to take over as Director (CEO) of Electrical Research and Development Association (ERDA) at Vadodara (Baroda), an Institution maintained by Electrical Industries and supported by CSIR. Since I wanted to assume this position on deputation from IITD, the period as per norms had to be restricted to two years. Mr KK Nohria (Crompton Greaves) and

Mr PR Bapat (GKW) were Governing council chairs during that period. Both were great visionaries committed to industrial growth. It was a pleasure for me to work with them as I came into close contact with doyens of Indian Industry. I organized a major international conference ELROMA jointly with IEEMA at Mumbai in 1991. Apart from facilitating continuing education program for Industry I gave research orientation to ERDA and promoted academia interaction through MOU.

As 'General Chair' I organized the first IEEE international conference on "Power Electronics, Drives and Energy Systems" (PEDES) during Jan.1996. Event was organized by IITD jointly with U of Wisconsin (USA) and IIT Kanpur. Prof Deepak Diwan of UW was another General Chair from USA. It was a grand event with good international participation. I am glad that my efforts to start this event resulted in a well established new series of PEDES conferences held every alternate year in different locations and branded as a quality conference under IEEE.

I was Head (Chairman) of the Electrical Engineering Department of IITD during 1998-2001. This was a major administrative responsibility to steer one of the biggest departments comprising around 50 Faculty and 100 support staff running 2 UG and 6 PG programs apart from around 100 doctoral students. I took it both as a challenge and opportunity to enhance academic and research output of a premiere IIT. Though managing highly competent and individualistic faculty was a challenge, well-structured democratic processes involving Faculty board and professorial committees were helpful. At the end of my term I had the fulfillment of effectively contributing to the growth of the department. I started a new Bachelors program in EE (Power) and a dual degree program in ICT. Prof VS Raju, the then Director was very supportive. Since department had acute shortage of space I succeeded in adding a floor on the top and reorganized the laboratories for better teaching and research. I could inject a few bright faculty. Deregulation and decentralization were strengths of IITs that came in handy.

In 2003, I was invited by Govt. of India to take over as the founding Director of NIT, Surathkal after earler RECs were converted to NITs. Then HRD minister was keen to have IIT professors to steer these new NITs. Thus a few IIT professors opted to take up this unique responsibility to bring in IIT culture in NITs. I took major academic and administrative reforms in tune with IIT norms at Surathkal with positive results. Course/ curriculum structure was modified. Laboratories were modernized through World Bank Funds under TEQIP. NITK Beach was formed. Research programs re-oriented. I promoted international collaboration through linkages with Institutions in Korea and Japan. Feedback from Faculty and students indicated that I could inject new spirit in this NIT. Due to change in Central Government in 2004, the new minister decided to send back the above IIT professors and I was back in IITD in 2005. I am satisfied that strong views I conveyed to policy makers to make NITs on par with IITs are gradually receiving attention.

I took my second sabbatical during 2008 to be a visiting Professor at Ryerson University, Toronto, Canada. I developed and taught a new graduate course on "Alternate Energy systems" which was well received by the nearly 40 registered students. I used high tech classroom facility of the university that included 'blackboard' software. I wish Institutions in India developed similar classrooms for effective teaching and evaluations. I spent part of this sabbatical at GE, IISC and CPRI at Bengaluru, resulting value addition to my research.

I made several visits to leading Institutes and Industry as below during summer vacations: MIT(USA)- July 2002; GE (John F Welch) Technology Centre, Bengaluru- INAE Distinguished Professor cum visiting consultant- July 2007,May/July 2009, Oct-Dec.2008 , May- July 2010,Trident Powercrafts Pvt. Ltd, Bengaluru- Inae Dist. Industry Professor- June 2007.U Of Waterloo & Ryerson Univ-May-July 2011.

Finally I superannuated from the service of IITD in June 2012, thus ending my long innings of 42 years in this great institution, and decided to relocate to Bengaluru, although I could continue as emeritus professor at IITD.

Then Director of IITD nominated me for the position of Vice Chancellor of Central University of Karnataka (CUK) in Northern Karnataka, based on which a search committee suggested my name among a panel to the President (Visitor of the university) who picked my name. After some introspection I decided to take up this responsibility and took charge in Jan.2013. CUK was in a formative stage being operated from Gulbarga University Campus. I worked hard to move to university to its new designated 650 acre campus at Kadaganji, 30 km from Gulbarga (Kalburgi). My proud moment was when the new campus was inaugurated by the then HRD minister on 30th Nov.2013, which made faculty and students to rejoice. I also initiated new integrated science and engineering programs at CUK which is unique. My mission was to make the campus 'green' through planting of over 10,000 saplings. Then MHRD informed me that my appointment was for the residual period of the earlier VC and hence had to relinquish my post on 28th Feb. 2014. Since I never went after 'power' in my career, I gladly gave up. But I am convinced that these new central universities need lot of handholding by MHRD by ensuring visionary leadership and support similar to other central institutions.

Then new PES university at Bengaluru invited me to be an emeritus professor and academic advisor till July 2015. From March 2015 I am functioning as distinguished Professor at Central Power Research Institute at Bengaluru guiding researchers on 'Micro-grid'

I may list the highlights of my professional and research contributions as: a) State of art and highly cited research on Self Excited Induction Generators for off grid renewable energy based power generation, b) Field installation of pico-hydro plants in Karnataka based on my invention, c) Design, development and field installation of Wave Energy based induction generator in Kerala, d) Indigenous switched reluctance motor development jointly with Industry, e) CAD lab. for electric machine design, f)a novel 1-phase brushless ac generator - an improved version developed through support from MSME(GOI) and prototype 5kW, 1- ph. SEIG built for field trials for renewable energy applications, g) Design software for ARNO- convertors developed for ABB, h) Design software on induction motors with variable frequency supply for traction and cement mill drive for BHEL i) design software for performance evaluation of 3- phase induction motor for traction application with inverter fed supply" for BHEL, j) World bank supported Energy Audit facility at IITD .

I made short visits to several countries for professional engagements and conferences such as: United Kingdom (1987,89,93,95,2007), Denmark (1987), United States Of America (1982,89,95,2003,2010,2011), Oman (2001), Swtzerland (1984),Singapore (1997,2013,2014), Nepal (2004), Japan (2005,2010), Korea (2005),China (2005), Australia (2006), Thailand (2007), Taiwan (2009,14), Kazakhstan (2011), Turkey (2013) and Bhutan (2015). These resulted in international linkages and formulation and execution of joint programs with some of these countries such as research projects, short term courses and lab. development. I was coordinator of Indo-UK program on microprocessor applications in drives and DST nominated India Coordinator for the joint Indo- Canadian and Indo- Australian program on "Sustainable Energy". I led the Indian delegation for the Indo- Australia workshop on sustainable energy held in Sydney in 2006 and organised the Indo-Canada Workshop on 'Electricity generation using renewable energy' in 2009. I facilitated MOU and linkages with universities in Japan (Kumamoto, Kagoshima), Korea (KAIST, KIER), Canada (Waterloo, Ryerson), USA (Wisconsin,), UK (Sussex).

I had the privilege of teaching over 5000 students with fairly good feedback at UG and PG levels on Electric Machines, Drives, Energy conversion and renewable energy. Some of these courses are recorded in the studio of Educational Technology Centre of IITD, packaged in over 15

video modules available to other Institutes and beamed through TV channels. I am proud that I have taught among the brightest in the country that included well known IITD Alumni such as Raghuram Rajan (RBI), Vinod Khosla (VC promoter), Rajendran (NIIT). I have delivered over 180 popular and special lectures at the invitation of several organisations in India and Abroad (Canada, USA, Japan, UK, Singapore, Taiwan). My other contributions to knowledge dissemination activities included organizing series of curriculum workshops to prepare lab. manuals and new curriculum and Continuing Education programs targeting professionals.

My professional work is reflected through 300+ published papers, 100+ theses supervision, 90+ sponsored research and industrial consultancy projects, 40+ Technical reports, 7 manuals/conference proceedings, 18 patents and 100+ reviewed papers of several international journals including IEEE, IEE/IET, Elsevier.

My awards and recognitions include: Life Fellow of IEEE (Institution of Electrical and Electronics Engineers-USA), Fellow of Indian National Academy of Engineering (INAE), Fellow of IEE/IET (UK), Life Fellow of the Institution of Engineers,(India), Life Fellow of IETE(Institution of Electronics and Telecommunication Enginers-India), ISTE/Maharashtra Govt. Award for outstanding research, IETE/Bimal Bose Award for contribution in Power Electronics.2007 IEEE/PES Chapter Outstanding Engineer Award. A recent international recognition was to choose me by IEEE/IAS as Distinguished Lecturer (DL) for 2014-15 to facilitate being invited globally to deliver specialist lectures.

My significant contribution to outreach activities are: General Chair of the 1st IEEE International Conference on Power Electronics, Drives and Energy Systems for Industrial Growth (PEDES' 96) during 1996 in New Delhi; Patron for PEDES-2012 during Dec.2012 at Bangalore; Technical Chair of the IEEMA organised Conference ELROMA in 1992, 2004 and annual conference of Elec. Engg Div. of IE(I) in 2005; Symposium chair of IEEE symposium on "Sustainable Energy and Global synergy" held in Ryerson Univ. Toronto in 2008; general chair of the INAE conference on "Research Policy for Sustainable Energy" in New Delhi (2009); convener of Electrical Engineering Section and member of Energy Forum of INAE. As consultant to UN-ESCAP, I steered the UN supported Workshop on "Advances in Fossil Fuel Technologies and Investments for Power Generation" in New Delhi (*June 2012) Organized by* APCTT UNECE and UNCTAD that was followed with the UN workshop in Almaty (Kazakhstan) in Nov. 2012, I had the privilege to serve several professional societies such as IEEE, IEE/IET, IE(I), ISTE, IETE in several capacities I have served in National committees of Industry associations like CII, IEEMA & FICCI and also in committees of UPSC, AICTE, NBA, NPIU, DST, TIFAC, DSIR, MoI, MNES, CBIP, BEE, CSIR, NRDC, MHRD,TERI etc. I am member of appellate committee of NBA and mentor /auditor of Engineering Institutions supported by World Bank Project, TEQIP.

My interest areas are Electric Machines, Drives, Power Electronics, Renewable Energy & Energy efficiency and engineering education. Apart from these mainstream subjects, I have passion on value education and sustainable technologies that brought me to work with value education and rural technology centres of IITD. I tried to promote Indian values among IIT community through lectures from external experts including Ramakrishna Mission with teachings of Swami Vivekananda who combines science and spirituality.

My family comprises of wife Gowri, daughter Rashmi and son Raghunandan who works with General Electric in Singapore. My son-in law Arun is an R&D manager with Nokia in Bengaluru. My daughter in law Anubhuti is an NID (Ahmedabad) graduate and a freelance artist. I have a grandson Ritunjay from my daughter and a granddaughter Anvi from my son.

I am very proud of my country that provided me opportunity to evolve from a humble rural ambience to a position of recognition in Nation's Capital.

Necessity is the mother of innovation - an example

A. Sanatkumar

Prologue:

In the context of technology development, 'invention' may be seen as creation of a hitherto unknown concept, design, material, or process etc., through the all important one percent inspiration 'gifted' to the inventor (seeker of answers) by evolutionary processes of Nature, and who subsequently by his/her own ninety nine percent 'perspiration', successfully achieves the end result. Inventors are rare persons, born too few and far between, although their inventions can have tremendous impact on society and mankind. By contrast, 'innovation'[1] is a work-around for any obstacles that we may face in the way of technology development. It is generally a case of developing an alternative design, material or manufacturing process when indigenising a component or system for which we do not have in our country, industrial infrastructure to the same extent a sour collaborator's designers from whom we obtained the design. Problem solving innovations are more common place than inventions, and are being implemented all the time around us - if only we take the trouble to recognise them - often yielding huge positive outcomes. This article is about a small innovative idea[2]which although might look simple and obvious in retrospect, did result in saving a make-or-break situation.

Introduction:

Because of their ability to effectively use limited resources of Natural Uranium, the Pressurized Heavy Water Reactor(PHWR) concept, based on the CANDU reactor system developed by Canada, has been chosen to be the basis for nuclear power in our country. Collaboration agreement (1960s) between India and Canada envisaged almost complete Canada-supply for the first Unit at Rajasthan (RAPS-1). Recognising the importance of achieving self-sufficiency in these high-technology areas, Dr Bhabha and his associates had included in the collaboration agreement, provisions for increased India-supply of materials, equipment and components for RAPS-2. Further, the agreement envisaged that India could use the Canadian designs, even beyond RAPS2 (with further indigenous

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[1] Innovation (Wikipedia) is the process of making changes to something established by introducing something better and, as a consequence, new.

[2] 'One small step for Indian PHWR!' (with due apologies to Mr. Neil Armstrong http://www.nasa.gov/mission_pages/apollo/apollo11_audio.html)

innovations and adaptations) for constructing more PHWR units at Kalpakkam (Tamil Nadu) and elsewhere in India.

PHWRs are well-known for their neutron economy, contributed to a large extent by the on-power refuelling capability that the design is endowed with. Fuel in the form of half a metre long 'bundles' are placed inside horizontal tubular assemblies called Coolant Channels (Fig. 1).Heavy Water at high pressure and temperature flows through each of these channels, picking up the (heat) energy liberated as a result of nuclear fission in the fuel.

In order to refuel the reactor without shutting it down (that is, to carry out on-power refuelling), it is necessary to gain access to the fuel bundles inside each Coolant Channel. Two remotely operated, automatic, computer controlled Fuelling Machine (FM) Heads, functioning in unison, are used for this purpose. The first FM Head, clamped to one end of a channel, gains access into the Coolant Channel by removing the Canada-invented ,ingenious, self-energised[3] sealing mechanism (called Sealing Plug), and subsequently removing another similar mechanism used as a shield against nuclear radiations streaming axially from the channel (called Shielding Plug). Sealing and Shielding Plugs are identified in Fig. 1, as are the Fuel Bundles. The FM Head at the upstream end, then pushes new fuel into the channel while the second FM Head, clamped to the downstream end of the same channel, after removing identical Sealing and Shielding Plugs at that end, receives the spent fuel. Fuel received in the downstream FM Head is subsequently discharged to the Spent Fuel Storage Bay for safe underwater storage. When refuelling operations on a channel are completed, the FM Heads safely reinstall the Shielding and Sealing Plugs at both ends before unclamping and proceeding to refuel the next channel. All the operations have to be carried out remotely and automatically in order to ensure utmost reliability and safety. The Fuel Handling System comprises of several complex systems and sub-systems involving almost all aspects of engineering, including high precision mechanical engineering, advanced oil and water hydraulics, computer control etc.

Design and safe operation require the Sealing Plugs to be precision engineered and manufactured. A cross section of a typical Sealing Plug (in this case for 540 MWe PHWR at Tarapur 3&4) is shown in Fig. 2. Sealing Plugs for 220 MWe PHWRs are slightly smaller, but utilise the same principle of operation.

The Sealing Plug Assembly, as installed in the End Fitting of the Coolant Channel is shown in the top half of the cross sectional view in Fig. 2. In this condition, it is required to withstand hydrostatic loads acting on the Seal Disc (Item 5 in Fig. 2) which provides sealing against high pressure coolant heavy water. For this purpose, a set of six Jaw Segments are expanded into a groove (with one side of it being conical) in the End Fitting, by pulling the Spider outwards using three telescopic co-axial Rams in the FM Head. To withstand the high hydrostatic force and share the load equally, the Jaw Segments need to

[3]'Self-energising' refers to the capability of the sealing element to automatically generate increasing gasket seating force with increasing pressure of the fluid being sealed, thereby ensuring that when fluid pressure increases, leakage past the sealing surface does not increase.

move uniformly outward. Moreover, the conical surface at the outer periphery of the Jaw Segments (see Fig. 3) should bear uniformly against the conical face of the groove in the End Fitting. To uninstall the Sealing Plug from the End Fitting for refuelling, the FM Head Rams push the Spider inwards to collapse the Jaw segments. Lower half of the cross sectional view of the Sealing Plug Assembly in Fig. 2 shows the Jaw Segments in the collapsed condition. Again, the Jaw Segments must move uniformly inwards, so as to ensure that in the fully retracted condition, none of them are projecting into the groove in the End Fitting and are well inside the outer diametre of the Sealing Plug. Clearly, to achieve uniform, smooth movement of the Jaw Segments and to safely withstand the high forces operating on the Sealing Plug, apart from use of high strength stainless steel material and robust design, they must also be manufactured to high precision.

In order to achieve their uniform and precise movement, each of the six Jaw Segments of a set are provided with a contoured non-circular hole (commonly referred to as a 'slot') comprising of two straight sides, connected at the top and bottom by two concentric circular arcs as shown in Fig. 3.Size of each slot is approximately 13 mm wide by 10 mm high by 18 mm long. It is essential that all the slots are located such that their common pitch circle is concentric with the conical surface at the outer periphery. Furthermore, all the internal surfaces of the slots need to have a smooth finish in order to minimise friction during their movement. Finally, the angle at which the slot (which engages with the 'finger' of the mating component, namely 'Spider' -- see item 3 in Fig. 2) must be identical in all the Jaw Segments. The design envisages that the six Jaw Segments are not interchangeable; that is, all six Segments must stay together during manufacture and assembly. One Segment from a set is not to be interchanged with another of a different set. The Jaw Segments are made of Precipitation Hardened Stainless Steel, as are most of the other parts.

The Shielding Plug is similar in construction to the Sealing Plug, but is smaller in overall diametre and has a set of only three Jaw Segments. Although this article mainly describes certain manufacturing aspects of Jaw Segments of Sealing Plugs, similar requirements and constraints are applicable to Shielding Plugs too.

How the 'necessity' arose:

We started our efforts towards indigenous manufacture of Sealing and Shielding Plugs in early 1970's. Readers may please keep in mind the very limited extent of nascent industrial infrastructure, particularly for precision manufacture, that existed in our country at that time.

Our efforts in indigenous manufacture began with attempts to use the manufacturing process sheets furnished by the Canadian Supplier of Sealing and Shielding Plugs for RAPS-1 as per the requirements of the Purchase Orders placed on him. From the beginning we realised that the manufacture of Jaw Segments could become be a critical path activity. Very soon it became evident that the processes used by the Canadian manufacturer could not be followed in India, because he had used spark erosion technique whereby all six slots were 'sunk' simultaneously using six electrodes moving in unison.

Hectic efforts to locate manufacturers in India having spark erosion machines of the required capacity were not encouraging. Extensive trials undertaken to make prototype pieces, limited only to the slot, just to determine the different spark erosion parameters, were unsuccessful in terms of achieving accuracy and surface finish. Time required to complete even a single slot and electrode wear were other major issues. There was no question of sinking six slots simultaneously as was done in Canada for RAPS-1 because spark erosion machine having the requisite capacity was not available at that time.

Thus, broaching became the selected method for making the contoured non-circular slots. When contacted, the initial reaction of the supplier of special purpose broaches in India (who also had an appropriate broaching machine so that he could be given single point responsibility not only to supply the broaches but also carry out the broaching operations) was: "we have never machined stainless steel nor have we supplied broaches for use with this material". However, they subsequently agreed to work with their foreign collaborators and attempt indigenous manufacture of the required broaches.

Sustained discussions with the broach manufacturer brought to light that their collaborator's effort in the past to manufacture broaches for this application was not very successful since the broaches, even though properly designed and made of the highest quality tool steel available at that time, frequently tended to break during the broaching operation. This, apart from increased cost of tooling and decreased productivity, often additionally resulted in unacceptable damage to the component being broached.

It was this feedback from the broach manufacturer which presented the 'necessity' that led to our 'innovation'.

The 'Eureka!' moment:

Feedback as above was indeed very discouraging. Having failed to develop spark erosion technique, inability to make the slots even by the second alternative, namely broaching, would mean that in order to complete manufacture of Sealing and Shielding Plug assemblies in India, at least the finish machined Jaw Segments need to be imported. This was not found desirable, since, we could be faced with difficult-to-resolve issues due to potential incompatibility with mating components manufactured by a different manufacturer, when the Jaw Segments are finally put together with their other mating parts, to make up the respective Plug Assemblies. The only other alternative appeared to be to import complete Sealing and Shielding Plug Assemblies, manufactured abroad. Not only would this have been a more costly proposition, but would also have meant that remaining machining operations that could otherwise have been carried out in India are actually done abroad. These scenarios would have led to big setback to our resolve to develop indigenous capability to manufacture precision machined components, considering that construction of many more PHWRs to follow RAPS 2 were on the anvil.

We were quite determined to spare no efforts to make a success of indigenous manufacture of the Sealing and Shielding Plugs.

In pursuance of this aim, a detailed analysis to find out the possible reasons why frequent failure of the broaches took place, was undertaken along with the broach manufacturer, who incidentally, was also quite keen to participate in our Nuclear Power Programme. Apart from (a) normal tool wear and (b) mishandling of the broach during use, we felt that there might have been some non-optimal features in the broaching process itself that led to frequent failures experienced by the foreign collaborator.

Some of the requirements dictated by the design and dimensional constraints of the slot are:

(a) As previously described, to get the required dimensional accuracy, the slots for all six Jaw Segments must be made while they are integral as a single 'Jaw Blank'. The Jaw Segments are to be parted from the Jaw Blank only as a final operation after the slots and all other related features have been finish machined.

(b) The broaching tool would be slender and hence a pull-type broaching machine is to be used. No problem here since such a (horizontal) machine of the requisite capacity was available with the broaching manufacturer.

(c) In order to reduce the load on the broach, and to achieve the final surface finish as specified, each slot is to be made using a set of multi-pass broaches, whereby only limited material is removed from the slot surfaces in each pass (See Fig. 3). Also, coolant/lubricant oil to be supplied at the tool-and-job-interface in copious quantity, should be carefully selected, having requisite properties.

(d) In order to enable accurate insertion of the shank of the broach through the component and grip it in the chuck of the broaching machine, precisely located drilled and reamed circular pilot holes need to be pre-machined for each slot.

It is in this requirement (d) above that we located a potential cause for frequent failure of the broaches. Drilling and reaming of the six pilot holes in the Jaw Blank, corresponding to each slot, was being carried out in a vertical drilling/reaming machine using an indexing fixture that would allow successive location of the centre of each of the six holes to be machined, concentric to the spindle of the drilling machine.

On the other hand, broaching of the slots in the Jaw Blank was being made in a different machine (essentially a setup which is distinctly different from that for drilling and reaming) using a different indexing fixture. Even if both the fixtures are made to high accuracy, because they were different from each other, due to tolerance stack-up, indexing operation at the broaching machine may not have positioned the pilot hole at the ideal position with respect to the axis of pull of the broaching machine ram. This misalignment might have caused the broaching tool to bend to an unacceptable extent (even if only small in terms of dimensional errors), resulting in failure of the broaching tool.

Once this issue was identified as a possible cause for frequent broach failure, we suggested to the broach manufacturer that he should design and use a unified ,precision manufactured, indexing fixture that can be mounted on a vertical drilling/reaming machine as well as on a horizontal broaching machine (See Fig. 4).

Agreeing to give it a try, he designed and manufactured such a fixture in addition to a prototype set of multi-pass broaches. Needless to say this effort proved successful, although the special coolant/lubricant used in the broaching operation needed to be imported, as it was not available in India at that time. Tool wear and tear and broach breakages were brought down to acceptable levels.

A similar strategy was adopted for the manufacture of Shielding Plug Jaw Segments too.

Epilogue:

Implementation of the concept of combined Drilling-plus-Broaching Fixture went a long way in enabling us to satisfactorily manufacture Sealing and Shielding Plug Assemblies for the first time in India.

Since then, using this combined fixture concept, a total of nearly 19,000 Jaw Blanks (of Sealing and Shielding Plugs put together) for 14 reactors have been successfully broached.

Of course, there were several other technology-related problems too, not discussed in this article, which needed to be resolved and overcome in economically achieving our goals.

Among many examples, big and small, involved in indigenous technology development of On-power Fuel Handling Systems for PHWRs, is the development of Precipitation Hardening Stainless Steels by MIDHANI which has given us, to a very great extent, independence from having to import this important raw material.

Certainly, technology development is not static. By about 2005, several Indian manufacturers had acquired suitable Spark Erosion/Wire cutting machines. At the present time, slots in the Jaw Segments are spark eroded / wire cut, much as it was done in Canada for RAPS 1.

Acknowledgement:

The Author is grateful to Shri A.B Ghare who reviewed manuscript of this article and gave valuable suggestions for improvement.

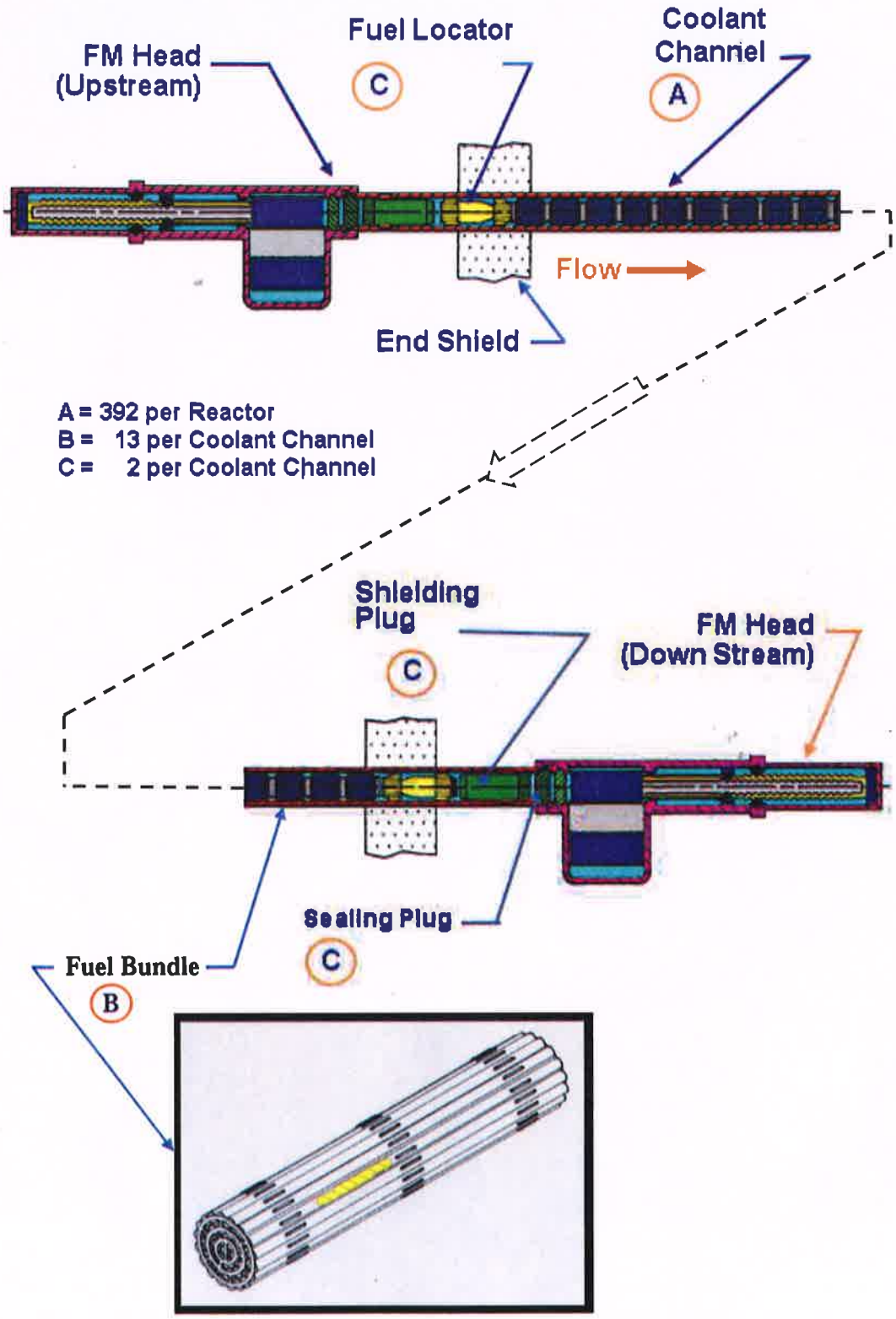
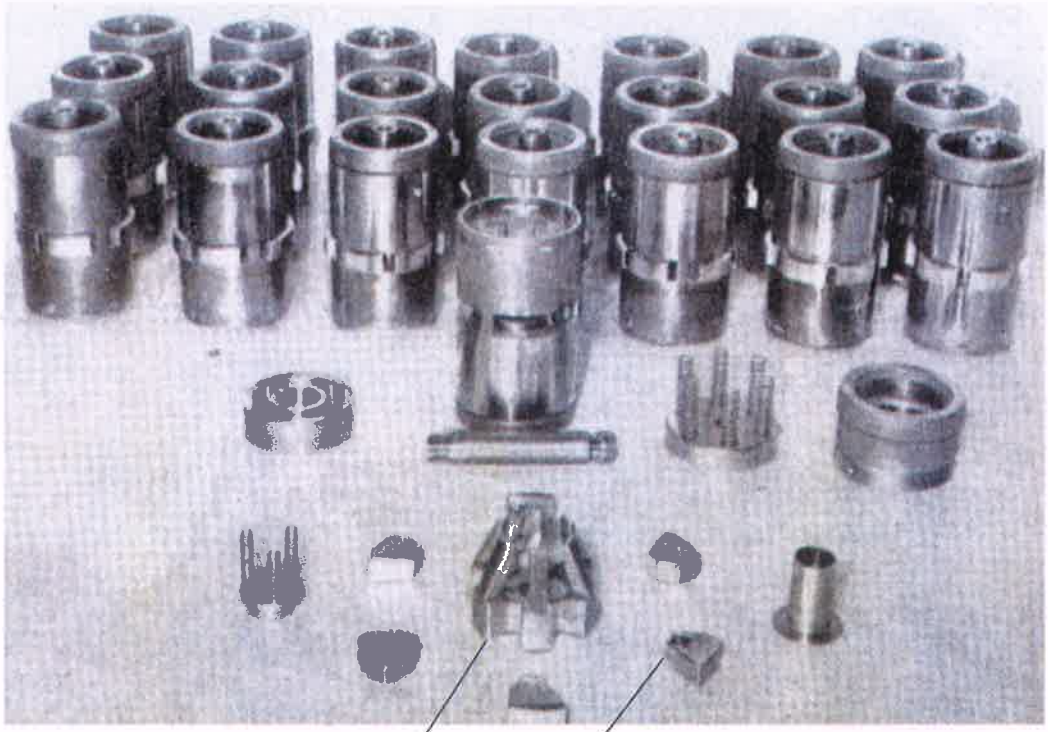


Fig 1 540 MWe PHWR Coolant Channel



1. Self-energising Seal
2. End Fitting
3. Spider
4. Jaw Segments [6 Nos]
5. Seal Disc

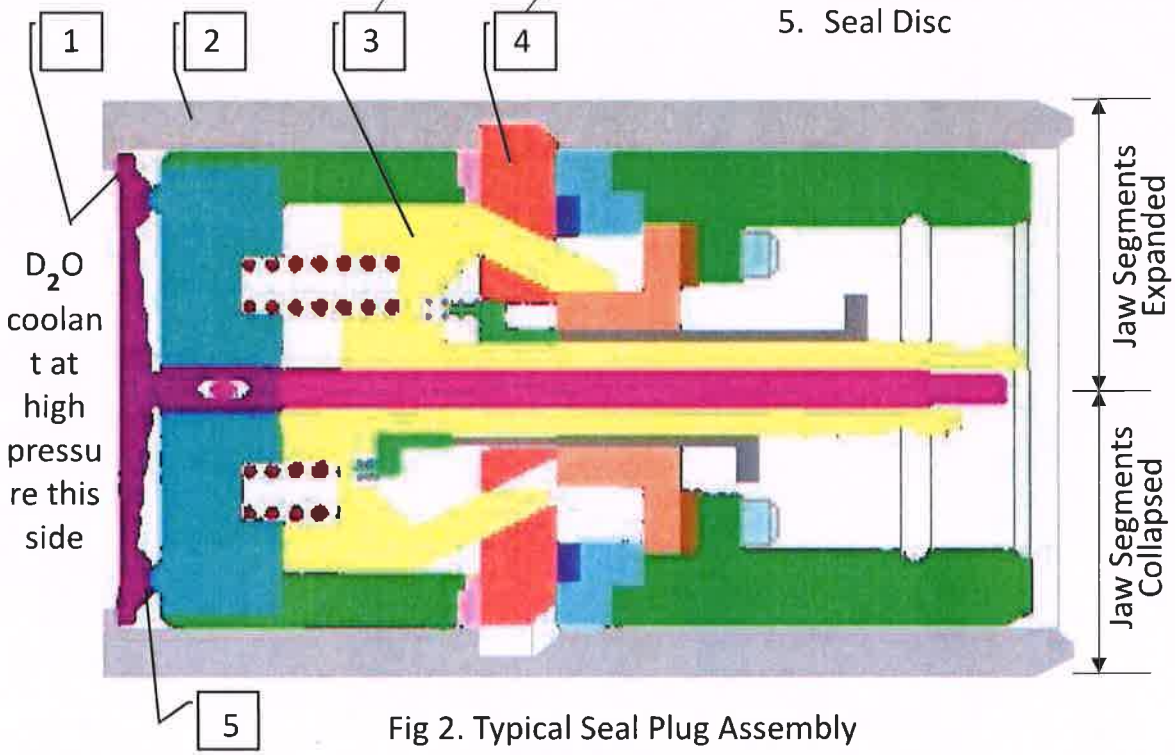


Fig 2. Typical Seal Plug Assembly

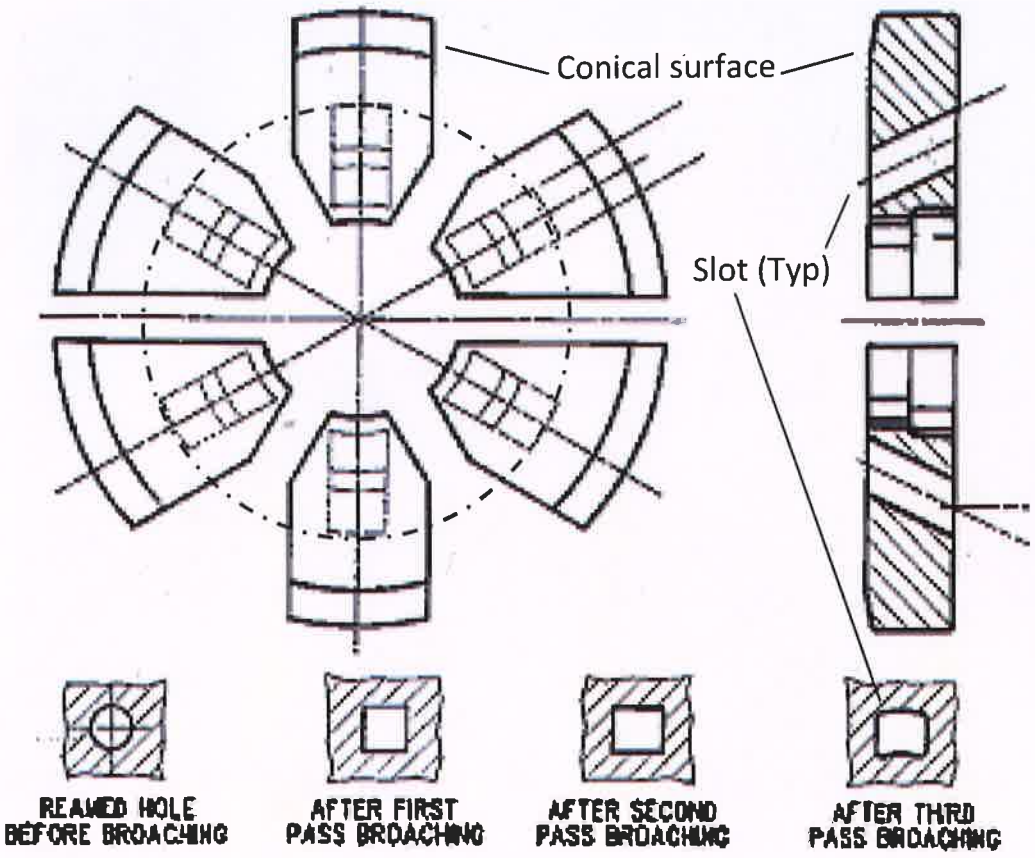


Fig 3. Jaw Segments and Broaching Passes

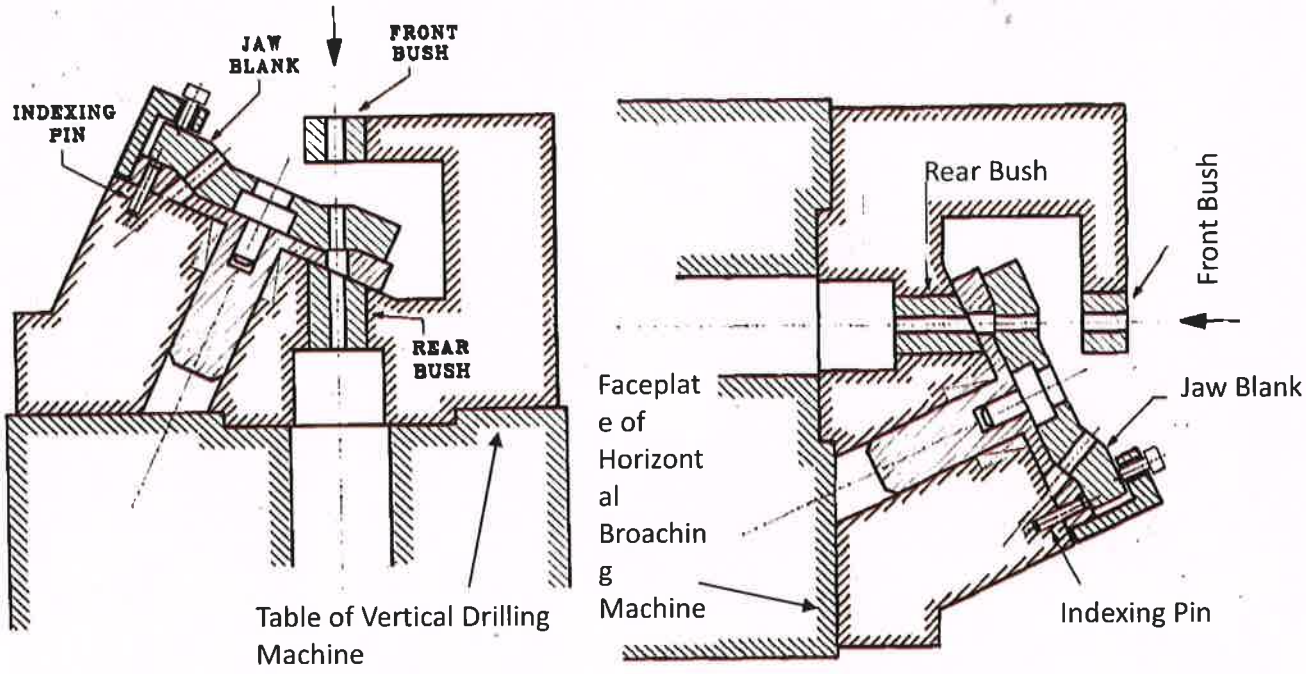


Fig 4. Drilling and Broaching Fixture (Conceptual)

Jaw Segments being broached in Horizontal Broaching Machine

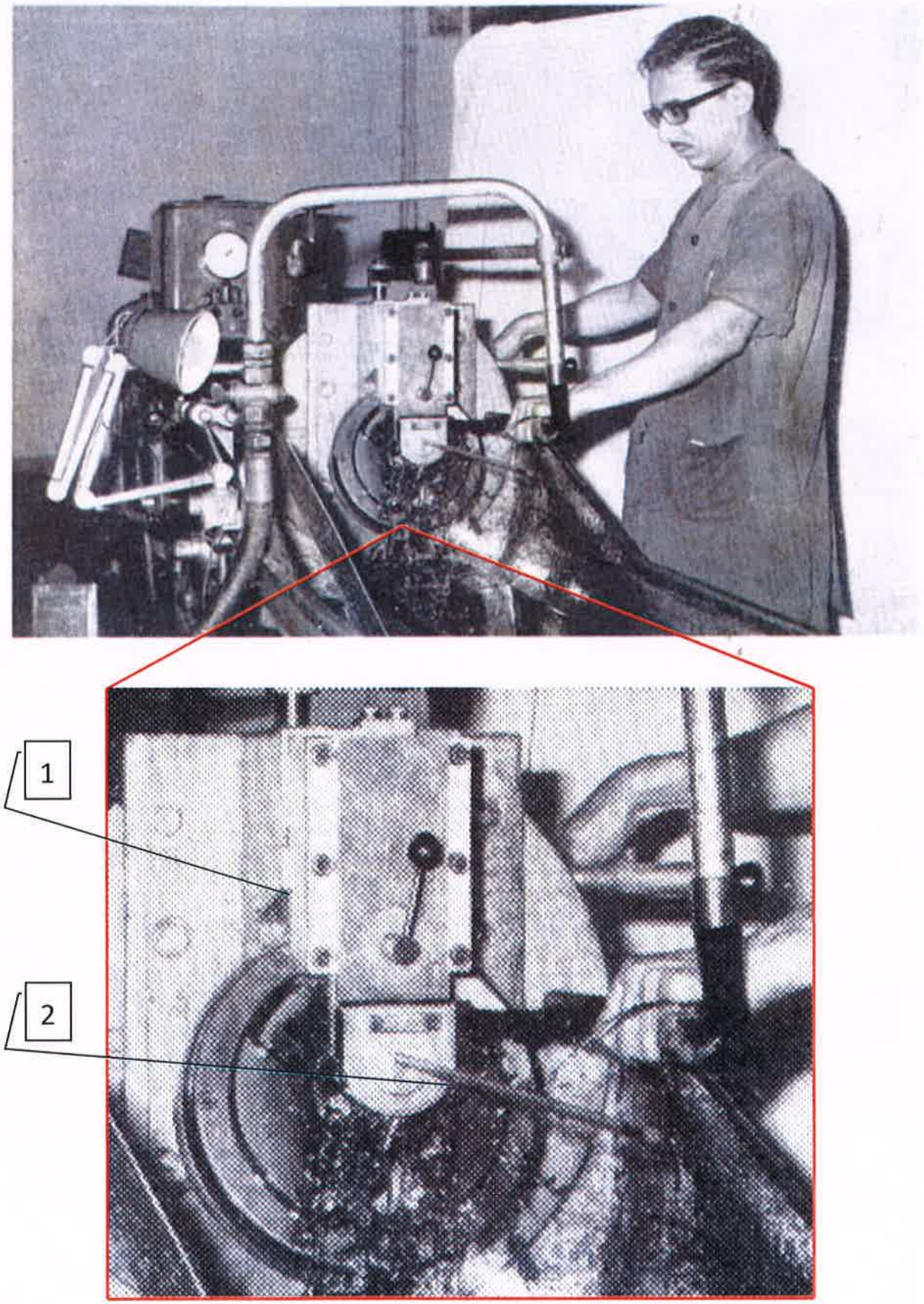


Fig 5. Enlarged View of Fixture [1] and Broach [2]

Civil Engineering

1. India's first semi-bullet train 'Gatimaan Express' Flagged Off

Gatimaan Express

India's fastest train, Gatimaan Express, was flagged off on April 5, 2016 by Railway Minister Suresh Prabhu from Nizamuddin Station. The new express train will operate between the national capital's Hazrat Nizamuddin station and Agra Cantonment station. Gatimaan Express has had two successful train tests and is now known as India's fastest train, surpassing New Delhi Habibganj Shatabdi Express, the former fastest train of India. Gatimaan Express is equipped with 5,400 HP electric locomotive and 12 modern coaches. Each coach costs around 2 to 2.5 crore and there will be two spare coaches besides the 12 regular coaches. Research Development and Standard Organisation were consulted in designing these coaches. The train will run at a maximum speed of about 160 km/hr and will cover a distance of around 200 kilometres in 100 minutes. The train will be equipped with eight inch LCD TVs, installed at the back of every seat. These screens will be powered by satellite and will broadcast live feed. The train has been installed with special features such as sliding doors, automatic fire alarm, advanced passenger information system, emergency breaking system, etc.

Source http://indiatoday.intoday.in/education/story/gatimaan-express-all-you-need-to-know/1/442170.html

2. First Computer Program Developed to Detect DNA Mutations in Single Cancer Cells

Researchers at The University of Texas MD Anderson Cancer Center have announced a new method for detecting DNA mutations in a single cancer cell versus current technology that analyzes millions of cells which they believe could have important applications for cancer diagnosis and treatment. Existing technology, known as next-generation sequencing (NGS), measures genomes derived from millions of cells versus the newer method for single-cell sequencing, called Monovar. Developed by MD Anderson researchers, Monovar allows scientists to examine data from multiple single cells. The study was, in part, funded by MD Anderson's Moon Shots Program, an unprecedented effort to significantly reduce deaths from cancer. "NGS technologies have vastly improved our understanding of the human genome and its variation in diseases such as cancer," said Ken Chen, Ph.D., assistant professor of Bioinformatics and Computational Biology. "However, because NGS measures large numbers of cells, genomic variations within tissue samples are often masked." This led to development of newer technology, called single cell sequencing (SCS), that has had a major impact in many areas of biology, including cancer research, neurobiology, microbiology, and immunology, and has greatly improved understanding of certain tumor characteristics in cancer. Monovar improves further on the new SCS's computational tools which scientists found "lacking" by more accurately detecting slight alterations in DNA makeup known as single nucleotide variants (SNVs). "To improve the SNVs in SCS datasets, we developed Monovar," said Nicholas Navin, Ph.D., assistant professor of Genetics and co-author of the paper. "Monovar is a novel statistical method able to leverage data from multiple single cells to discover SNVs and provides highly detailed genetic data." Chen and Navin state that Monovar will have significant translational applications in cancer diagnosis and treatment, personalized medicine and pre-natal genetic diagnosis, where the accurate detection of SNVs is critical for patient care. This refinement of an existing technology could very well boost studies in many biomedical fields other than just cancer. The researchers believe it is a major advance for assessing SNVs in SCS datasets - crucial information for a variety of diseases. "With the recent innovations in SCS methods to analyze thousands of single cells in parallel with RNA analysis which will soon be extended to DNA analysis, the need for accurate DNA variant detection will continue to grow," said Chen. "Monovar is capable of analyzing large-scale datasets and handling different whole-genome protocols, therefore it is well-suited for many types of studies.

Source http://phys.org/news/2016-04-dna-mutations-cancer-cells.html

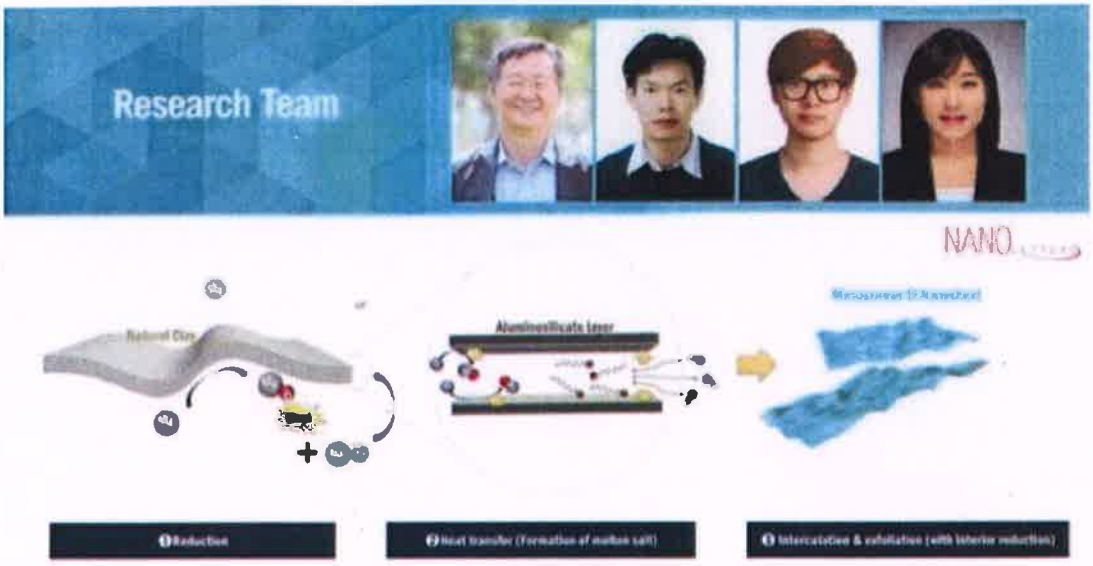
3. Autonomous Ships for the High Seas

Maritime RobotX competition: KAIST USV (shown in front) is navigating in the course in Marina Bay, Singapore during the competition.

Unmanned ships (i.e. robotic ships or drone ships) have received relatively little media attention compared to aerial drones and self-driving cars. However, their potential benefit and impact to scientific, defense, and industrial applications could be immense. Researchers at Korea Advanced Institute of Science and Technology (KAIST) have been developing technologies to enable and facilitate the realization of unmanned autonomous ships in the near future. Aerial drones and self-driving cars have been prominently featured in news headlines lately. Although there are numerous technical challenges and skepticism in fully replacing manned vehicle systems with unmanned ones, their common appearance in our daily lives does not seem to be very far away. Compared to unmanned aerial and ground vehicles, relatively little public attention has been paid to unmanned robotic ships, which are more commonly known as unmanned surface vessels (USVs). In fact, USVs have long attracted research interest in defense sectors for their applicability toward unmanned reconnaissance and surveillance missions. Recently, greater emphasis has been placed on USV intelligence and autonomy, and, in particular, USV usage in scientific and industrial applications has been more seriously investigated. In line with this, the inaugural Maritime RobotX Challenge (MRC), sponsored by the U.S. Office of Naval Research (ONR), was held in Singapore in 2014. The competition was composed of five mission tasks that were designed considering the capability and potential applicability of USVs in the future. Intelligence was a key factor, and all the mission tasks were required to be performed autonomously with no human intervention. Team "Angry Nerds" led by Prof. Jinwhan Kim in the Department of Mechanical Engineering at KAIST participated in the competition. The KAIST team advanced to the final and took the second place out of 15 teams from many universities including KAIST, Seoul National University, MIT, University of Tokyo, and National University of Singapore. The KAIST research team has continued to carry out research projects for developing USV system technologies, funded by the Korean government. The team has been particularly focusing on developing vehicle autonomy and perception capabilities by fusing various sensor information. The developed USV system is expected to be applied to time-consuming and/or dangerous operations in marine environments such as hydrographic surveys, environmental monitoring, illegal fishing control, pollution management, and search and rescue. The team is also pursuing research towards automation of commercial ships for improved operational safety and efficiency. This has been an important issue in marine shipbuilding and transportation industries with increasing labour and energy costs and the new energy efficiency regulations imposed by the International Maritime Organization (IMO). Major research institutions and companies in Europe are already devoting great research effort, and KAIST has been trying to support the world's leading Korean shipbuilding industries to maintain their competitiveness and initiatives in next-generation shipping technology.

Source https://www.sciencedaily.com/releases/2016/03/160330182854.htm

4. Cost-Effective Production of Hydrogen from Natural Resources



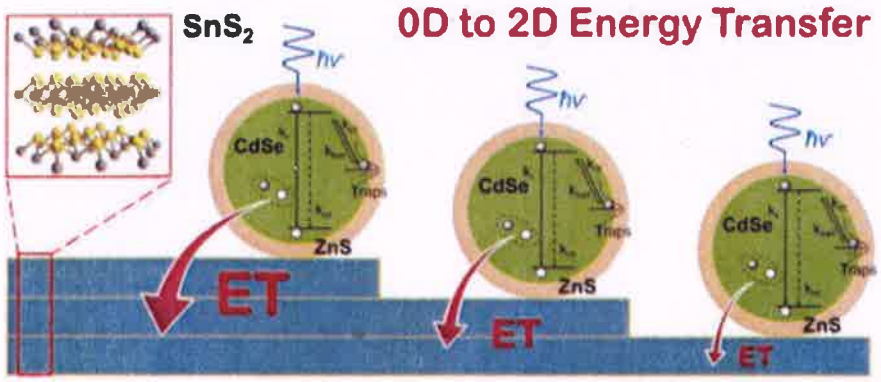
UNIST research team has developed a cost-effective and scalable technique for synthesizing SiNSs, using natural clay and salt.

Owing to their unbeatable electro-optical properties and compatibility with existing silicon technology, silicon nanosheets (SiNSs) are one of most exciting recent discoveries. They have been the most promising candidate for use in various applications, such as in the process of manufacturing semiconductors and producing hydrogen. A joint research team, led by Prof. Jae Sung Lee of Energy and Chemical Engineering at UNIST, South Korea has developed a cost-effective and scalable technique for synthesizing SiNSs, using natural clay and salt. Through this research, UNIST has taken a major step towards mass production of this ground-breaking material with relatively low cost. The research team reported an all-in-one strategy for the synthesis of high-purity SiNSs through the high-temperature molten salt (for example, NaCl)-induced exfoliation and simultaneous chemical reduction of natural clays. According to the team, these newly synthesized Si nanosheets are key components in the production of ever smaller electronic devices due to their ultrathin (thickness of ~5nm) body. The researchers say, "As the electrical and electronic devices are getting smaller and smaller, there is a great demand for manufacturing their individual components to be nanoscale." He continues, "Our new technique uses inexpensive natural clays and salt for preparing high-quality nanosheets, thereby cutting down production costs greatly." "Through the simultaneous molten-salt-induced exfoliation and chemical reduction of natural clay, both the salt and clay start to melt at a reaction temperature, ranging from 550°C to 700°C. The molten salt is, then, dissolved in the clay layers and disintegrated into individual nanosheets," said researchers. He continues, "Using the metallothermic reduction, metallic oxides inside clays can be exchanged with silicon." The team reports that these nanosheets have a high surface area and contain mesoporous structures derived from the oxygen vacancies in the clay. They add, "These advantages make the nanosheets a highly suitable photocatalyst with an exceptionally high activity for the generation of hydrogen from a water-methanol mixture."

Sourcehttps://www.sciencedaily.com/releases/2016/04/160405105811.htm

Electrical Engineering

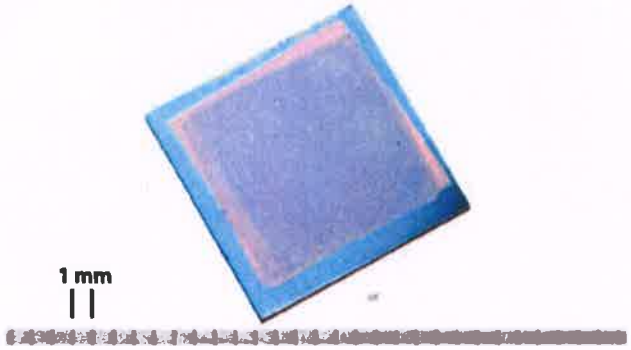
5. Quantum Dots Enhance Light-To-Current Conversion in Layered Semiconductors



Harnessing the power of the sun and creating light-harvesting or light-sensing devices requires a material that both absorbs light efficiently and converts the energy to highly mobile electrical current. Finding the ideal mix of properties in a single material is a challenge, so scientists have been experimenting with ways to combine different materials to create "hybrids" with enhanced features. Scientists from the U.S. Department of Energy's Brookhaven National Laboratory, Stony Brook University, and the University of Nebraska describe one such approach that combines the excellent light-harvesting properties of quantum dots with the tunable electrical conductivity of a layered tin disulfide semiconductor. The hybrid material exhibited enhanced light-harvesting properties through the absorption of light by the quantum dots and their energy transfer to tin disulfide, both in laboratory tests and when incorporated into electronic devices. The research paves the way for using these materials in optoelectronic applications such as energy-harvesting photovoltaics, light sensors, and light emitting diodes (LEDs). According the physical chemist who led this work at Brookhaven Lab's Center for Functional Nanomaterials (CFN), "Two-dimensional metal dichalcogenides like tin disulfide have some promising properties for solar energy conversion and photodetector applications, including a high surface-to-volume aspect ratio. But no semiconducting material has it all. These materials are very thin and they are poor light absorbers. So we were trying to mix them with other nanomaterials like light-absorbing quantum dots to improve their performance through energy transfer." The paper describes a fundamental study of the hybrid quantum dot/tin disulfide material by itself. The work analyzes how light excites the quantum dots (made of a cadmium selenide core surrounded by a zinc sulfide shell), which then transfer the absorbed energy to layers of nearby tin disulfide. "We have come up with an interesting approach to discriminate energy transfer from charge transfer, two common types of interactions promoted by light in such hybrids," said Prahlad Routh, a graduate student from Stony Brook University . "We do this using single nanocrystal spectroscopy to look at how individual quantum dots blink when interacting with sheet-like tin disulfide. This straightforward method can assess whether components in such semiconducting hybrids interact either by energy or by charge transfer." The researchers found that the rate for non-radiative energy transfer from individual quantum dots to tin disulfide increases with an increasing number of tin disulfide layers. But performance in laboratory tests isn't enough to prove the merits of potential new materials. So the scientists incorporated the hybrid material into an electronic device; a photo-field-effect-transistor; a type of photon detector commonly used for light sensing applications. The hybrid material dramatically enhanced the performance of the photo-field-effect transistors-resulting in a photocurrent response that was 500 percent better than transistors made with the tin disulfide material alone. "This kind of energy transfer is a key process that enables photosynthesis in nature," said researchers. "Researchers have been trying to emulate this principle in light-harvesting electrical devices, but it has been difficult particularly for new material systems such as the tin disulfide we studied. Our device demonstrates the performance benefits realized by using both energy transfer processes and new low-dimensional materials." The researchers conclude, "The idea of 'doping' two-dimensional layered materials with quantum dots to enhance their light absorbing properties shows promise for designing better solar cells and photodetectors."

Source https://www.sciencedaily.com/releases/2016/04/160408132447.htm

6. Future Devices to Transmit Data 10 Times Faster: Graphene Ensures Data Fidelity for Future Wireless Devices



A microchip containing graphene protects one THz optical sources.

EPFL and UNIGE scientists have developed a microchip using graphene that could help wireless telecommunications share data at a rate that is ten times faster than currently possible. "Our graphene based microchip is an essential building block for faster wireless telecommunications in frequency bands that current mobile devices cannot access," says EPFL scientist Michele Tamagnone.

Graphene acts like polarized sunglasses: Their microchip works by protecting sources of wireless data -- which are essentially sources of invisible radiation -- from unwanted radiation, ensuring that the data remain intact by reducing source corruption. They discovered that graphene can filter out radiation in much the same way as polarized glasses. The vibration of radiation has an orientation. Like polarized glasses, their graphene-based microchip makes sure that radiation that only vibrates a certain way gets through. In this way, graphene is both transparent and opaque to radiation, depending on the orientation of vibration and signal direction. The EPFL scientists and their colleagues from Geneva used this property to create a device known as an optical isolator.

Faster Uploads in the Terahertz Bandwidth: Moreover, their microchip works in a frequency band that is currently empty, called the Terahertz gap. Wireless devices work today by transmitting data in the Gigahertz range or at optical frequencies. This is imposed by technological constraints, leaving the potential of the Terahertz band currently unexploited for data transmission. But if wireless devices could use this Terahertz bandwidth, your future mobile phone could potentially send or receive data tens of times faster than now, meaning better sound quality, better image quality and faster uploads. The graphene-based microchip brings this Terahertz technology a step closer to reality. This discovery addresses an important challenge that was so far unsolved due to lacking technologies, confirming once more the extraordinary physical properties of graphene.

Source https://www.sciencedaily.com/releases/2016/04/160406074510.htm

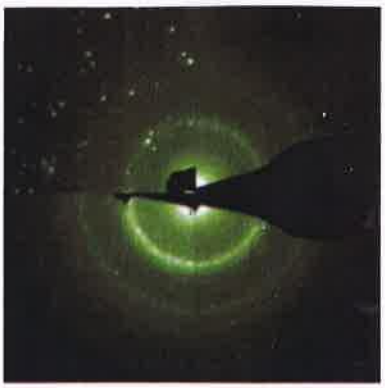
7. SpaceX Rocket Lands Safely on a Ship at Sea for the First Time

The SpaceX Falcon 9 rocket lifts off from launch complex 40 at the Kennedy Space Center in Cape Canaveral,

April 8, 2016 was a landmark day for the SpaceX Falcon 9 rocket. It launched into space a resupply capsule bearing a new inflatable habitat for the International Space Station. Then the rocket's "first stage" returned to Earth for a sea landing — without exploding. Though the SpaceX rocket had successfully landed on solid ground before; the last attempt to land the rocket on a barge at sea ended in a fiery crash. "The SpaceX Falcon 9 rocket lifted off, carrying an inflatable space module that will be added to the station. NASA hopes this kind of expandable room in space could someday help astronauts get to Mars," NPR's Geoff Brumfiel reports. "As the rocket's second stage carried this cargo into orbit, the first stage did something unprecedented. It turned around, flew back to Earth and touched down vertically on a robotic barge floating off the coast of Florida." As NPR's Joe Palca reported earlier, the idea for inflatable habitats in space dates back to the 1990s when "the space agency was trying to figure out how to get astronauts to Mars, without the crew going crazy living in a tiny capsule for months on end." When it's folded up, the expandable room is about 6 feet by 6 feet, Joe says, but when inflated, "it's about 12 feet by 10 feet, approximately the size of a small RV." The new habitat could mean more comfortable living during a future trip to Mars. And the successful landing of the SpaceX rocket will mean much more affordable space travel, as SpaceX can reuse the expensive "first stage," Geoff says.

Source http://www.npr.org/sections/thetwo-way/2016/04/08/473572033/spacex-rocket-lands-safely-on-a-ship-at-sea-for-the-first-time

8. Recording-Breaking Steel Could be Used for Body Armour, Shields for Satellites



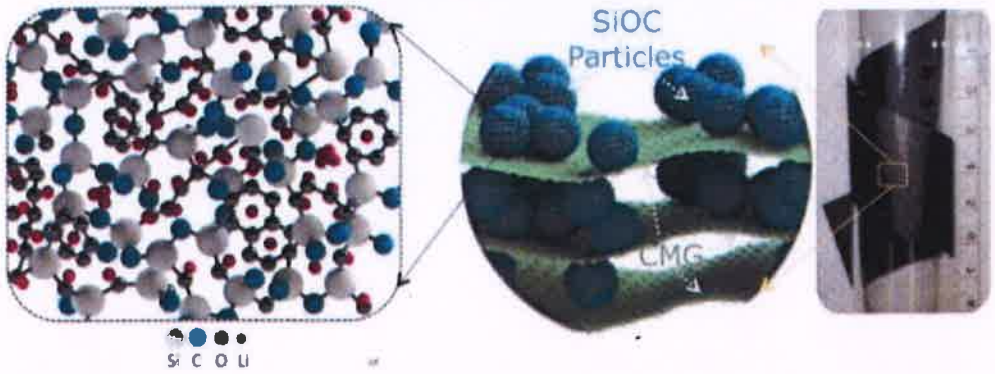
This is a transmission electron microscopy image of different levels of crystallinity in the amorphous alloy.

A team of engineers has developed and tested a type of steel with a record-breaking ability to withstand an impact without deforming permanently. The new steel alloy could be used in a wide range of applications, from drill bits, to body armour for soldiers, to meteor-resistant casings for satellites. The material is an amorphous steel alloy, a promising sub-class of steel alloys made of arrangements of atoms that deviate from steel's classical crystal-like structure, where iron atoms occupy specific locations. Researchers are increasingly looking to amorphous steel as a source of new materials that are affordable to manufacture, incredibly hard, but at the same time, not brittle. The researchers believe their work on the steel alloy, named SAM2X5-630, is the first to investigate how amorphous steels respond to shock. SAM2X5-630 has the highest recorded elastic limit for any steel alloy, according to the researchers--essentially the highest threshold at which the material can withstand an impact without deforming permanently. The alloy can withstand pressure and stress of up to 12.5 giga-Pascals or about 125,000 atmospheres without undergoing permanent deformations. The researchers are from the University of California, San Diego, the University of Southern California and the California Institute of Technology. "Because these materials are designed to withstand extreme conditions, you can process them under extreme conditions successfully," said Olivia Graeve, a professor of mechanical engineering at UC San Diego, who led the design and fabrication effort. To make the solid materials that comprise the alloy, Graeve and her team mixed metal powders in a graphite mold. The powders were then pressurized at 100 mega-Pascals, or 1000 atmospheres, and exposed to a powerful current of 10,000 Ampers at 1165°F (630°C) during a process called spark plasma sintering. The spark plasma sintering technique allows for enormous time and energy savings, Graeve said. "You can produce materials that normally take hours in an industrial setting in just a few minutes," she said. The process created small crystalline regions that are only a few nanometers in size, with hints of structure, which researchers believe are key to the material's ability to withstand stress. This finding is promising because it shows that the properties of these types of metallic glasses can be fine-tuned to overcome shortcomings such as brittleness, which have prevented them from becoming commercially applicable on a large scale, researchers said. Researchers at USC tested how the alloy responds to shock without undergoing permanent deformations by hitting samples of the material with copper plates fired from a gas gun at 500 to 1300 meters per second. The material did deform on impact, but not permanently. The Hugoniot Elastic Limit (the maximum shock a material can take without irreversibly deforming) of a 1.5-1.8 mm-thick piece of SAM2X5-630 was measured at 11.76 ± 1.26 giga-Pascals. By comparison, stainless steel has an elastic limit of 0.2 giga-Pascals, while that of tungsten carbide (a high-strength ceramic used in military armour) is 4.5 giga-Pascals. This isn't to say that SAM2X5-630 has the highest elastic limit of any material known; diamonds top out at a whopping 60 giga-Pascals-- they're just not practical for many real-world applications. "The fact that the new materials performed so well under shock loading was very encouraging and should lead to plenty of future research opportunities," said researchers. The primary focus of future research efforts on these alloys is increasing the weight of the materials to make them more resistant to impacts.

Source https://www.sciencedaily.com/releases/2016/04/160405105603.htm

Energy Engineering

9. Paper-like Battery Electrode Made With Glass-Ceramic



Gurpreet Singh, Kansas State University associate professor of mechanical and nuclear engineering, and his research team have developed a paper-like battery electrode using silicon oxycarbide glass and graphene

A paper-like battery electrode developed by a Kansas State University engineer may improve tools for space exploration or unmanned aerial vehicles. Gurpreet Singh, associate professor of mechanical and nuclear engineering, and his research team created the battery electrode using silicon oxycarbide-glass and graphene. The battery electrode has all the right characteristics. It is more than 10 percent lighter than other battery electrodes. It has close to 100 percent cycling efficiency for more than 1000 charge discharge cycles. It is made of low-cost materials that are byproducts of the silicone industry. And it functions at temperatures as low as minus 15°C, which gives it numerous aerial and space applications. Singh's research team has been exploring new material combinations for batteries and electrode design. It has been difficult to incorporate graphene and silicon into practical batteries because of challenges that arise at high mass loadings -- such as low capacity per volume, poor cycling efficiency and chemical-mechanical instability. Singh's team has addressed these challenges by manufacturing a self-supporting and ready-to-go electrode that consists of a glassy ceramic called silicon oxycarbide sandwiched between large platelets of chemically modified graphene, or CMG. The electrode has a high capacity of approximately 600 miliampere-hours per gram -- 400 miliampere-hours per cubic centimeter -- that is derived from silicon oxycarbide. The paper-like design is made of 20 percent chemically modified graphene platelets. "The paper-like design is markedly different from the electrodes used in present day batteries because it eliminates the metal foil support and polymeric glue -- both of which do not contribute toward capacity of the battery," Singh said. The design that Singh's team developed saved approximately 10 percent in total weight of the cell. The result is a lightweight electrode capable of storing lithium-ion and electrons with near 100 percent cycling efficiency for more than 1000 charge discharge cycles. The most important aspect is that the material is able to demonstrate such performance at practical levels, Singh said. The paper electrode cells also are able to deliver a capacity of 200 miliampere-hour per gram even when kept at minus 15°C for about a month, which is quite remarkable considering that most batteries fail to perform at such low temperatures, Singh said. "This suggests that rechargeable batteries from silicon-glass and graphene electrodes may also be suitable for unmanned aerial vehicles flying at high altitudes, or maybe even space applications," Singh said. The silicon oxycarbide material itself is quite special, Singh said. It is prepared by heating a liquid resin to the point where it decomposes and transforms into sharp glasslike particles. The silicon, carbon and oxygen atoms get rearranged into random 3-D structure and any excess carbon precipitates out into cellular regions. Such an open 3-D structure creates large sites for reversible lithium storage and smooth channels for lithium-ion transportation. This structure and mechanism of lithium storage is different than crystalline silicon electrodes. Silicon oxycarbide electrodes are expected to be low cost because the raw material -- liquid resin -- is a byproduct of the silicone industry. Moving forward, Singh and his team want to address practical challenges. Singh's goal is to produce this electrode material at even larger dimensions. For example, present-day pencil-cell batteries use graphite-coated copper foil electrodes that are more than one foot in length. The team also would like to perform mechanical bending tests to see how they affect performance parameters. "Ultimately, we would like to work with industry to explore production of lithium-ion battery full-cells," Singh said. "Silicon oxycarbide can also be prepared by 3-D printing, which is another area of interest to us."

Source https://www.sciencedaily.com/releases/2016/03/160331124727.htm

10. Diagnosing Ear Infection Using Smartphone

Low-cost custom-made video-otoscope that can be connected to a smartphone in diagnosing middle ear infections.

Researchers at Umeå University in Sweden have developed a method that simplifies the diagnosis of ear infections (otitis media), something which annually affects half a billion children worldwide. The software-based method automatically analyses images from a digital otoscope and enables highly accurate diagnoses. "Because of lack of health personnel in many developing countries, ear infections are often misdiagnosed or not diagnosed at all. This may lead to hearing impairments, and even to life-threatening complications," says Claude Laurent, researcher at the Department of Clinical Sciences at Umeå University and co-author of the article. "Using this method, health personnel can diagnose middle ear infections with the same accuracy as general practitioners and paediatricians. Since the system is cloud-based, meaning that the images can be uploaded and automatically analysed, it provides rapid access to accurate and low-cost diagnoses in developing countries." The researchers at Umeå University have collaborated with the University of Pretoria in South Africa in their effort to develop an image-processing technique to classify otitis media. The software system consists of a cloud-based analysis of images of the eardrum taken using an otoscope, which is an instrument normally used in the medical examination of ears. Images of eardrums, taken with a digital otoscope connected to a smartphone, were compared to high-resolution images in an archive and automatically categorised according to predefined visual features associated with five diagnostic groups. Tests showed that the automatically generated diagnoses based on images taken with a commercial video-otoscope had an accuracy of 80.6 per cent, while an accuracy of 78.7 per cent was achieved for images captured on-site with a low cost custom-made video-otoscope. This high accuracy can be compared with the 64-80 per cent accuracy of general practitioners and paediatricians using traditional otoscopes for diagnosis. "This method has great potential to ensure accurate diagnoses of ear infections in countries where such opportunities are not available at present. Since the method is both easy and cheap to use, it enables rapid and reliable diagnoses of a very common childhood illness," says Claude Laurent.

Source https://www.sciencedaily.com/releases/2016/03/160330102850.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.

- **Bio-inspired Flapping Near Surface Underwater Vehicle**

Innovator : MNP Babu; **Guide :** Prof. Krishnankutty. P
College : Indian Institute of Technology Madras

The growing demand for reduction in CO_2 emissions from marine vehicles enthused researchers and scientists to design to come up with more efficient propulsion systems. In addition, the use of conventional screw propellers for these vessels results in the damage of the marine biological and eco-systems. The vibration and noise from the propellers have severe damaging effects on marine aquatic life. The natural propulsion systems with which the biological beings such as fishes and birds move are the most efficient. The engineering translation of the aquatic animal propulsion systems and its appropriate application to marine vehicles help to achieve movement with less power and hence resulting in the CO_2 emission reduction. The bio-inspired propellers are ecologically pure and provide good controllability to the marine vehicles. They also provide very good stopping and turning abilities and motion stabilization. Finally, the application of bio-inspired propellers to underwater vehicles reduces the hydrodynamic and acoustic signature (stealth characteristics) and thereby, unable to detect with synthetic aperture radars. In this research, a novel design of a bio-inspired robotic fish with pectoral and caudal fins, which operates at subsurface, is considered. A lift-based propulsion theory is used to estimate the thrust generated by pectoral fins (used as auxiliary thrust device) and an empirical method is used to estimate the torque at the caudal fin. The fish body shape and fin geometrical parameters are also important with regard to the resistance and powering aspects.

- **Soya Nuggets – A Novel Drug Delivery Vehicle**

Innovator : Utkarsh Bhutani, **Guide :** Dr. Saptarshi Majumdar
College : Indian Institute of Technology Hyderabad

Biodegradable polymers like gelatin, alginate, chitosan, dextran, gellan gum, starch, and cellulose can be used as innovative drug delivery vehicles/carriers as thin films, hydrogels, microgels, micelles, liposomes and many more. The idea of these vehicles was to achieve control drug release with minimal side effects. Most of the biodegradable polymers are water soluble, so ensuring the uniform distribution of hydrophobic drugs inside the vehicle is a challenging task. To overcome this, synthesis of polymeric beads, polymeric and drug nanoparticles came into the picture together with beta-cyclodextrins. The acceptance of these biodegradable polymeric vehicles is again limited by the use of some toxic chemicals during the formulation stage e.g. cross-linkers like glutaraldehyde, tripolyphosphate etc. Hydrogels prepared from sodium alginate and gelatin require cross-linkers for improved mechanical properties. This work aims at minimizing the above drawbacks and bringing into the picture the first use of soya nuggets as potential drug delivery vehicles. Soya's potential as a highly effective drug carrier comes from the fact that they undergo tremendous swelling which can come handy at the time of drug loading and release. The high swelling degree is a result of high porosity and network structure of swelled soya nuggets. Just as any other biodegradable polymer carrier, soya nuggets were tested for their swelling behavior, mechanical properties, and drug release characteristics. The effect of ph was evaluated on swelling as well as on drug release. It was also observed that the nugget weight also influenced the swelling degree, which in turn affected the mechanical properties and loading efficiency of the drug. The swelling degree of soya nuggets can be taken into an advantage, by loading high amount of drug inside. The experimental data helped in predicting the swelling, diffusion and drug release kinetics.

Source http://gyti.techpedia.in