

nerd

notes on engineering research and development

An IITK Students' Publication

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Introducing SCoPE Talk Series

Science Communication and Public Engagement

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IIT K @ 50: The Year of Student Initiatives and more...

From Editor's Desk

The time since the launch of previous issue of NERD in November'09 has been quite eventful in two major contexts – completion of student (technical) projects and spread of awareness about science communication. Abhyast (Boeing- IIT Kanpur Autonomous Vehicle) project was completed and demonstrated on January 26, 2010. The President of India saw the demonstration of Jugnu (IIT K Nanosatellite Project) on March 6, 2010. NERD team kicked off 2010 with the start of SCoPE (Science Communication and Public Engagement) talk series where science communicators like Mr. Arvind Gupta (Eminent science toymaker, and Distinguished Alumnus Awardee, IIT K) and Ms. S. Priyadarshini (Editor, *Nature India*) gave talks about their exemplary contribution in outreach and popularization of science. ICARUS (Indian Conference on Academic Research by Undergraduate Students) is another student-led initiative that encompasses both these aims- showcase and promotion of undergraduate research, and their ability to get their work across to their peers.

The launch of this issue of NERD in the inauguration ceremony of ICARUS by the Principal Scientific Advisor, Government of India, Dr. R. Chidambaram, sets the next target for NERD- to promote student research and its communication in other technical colleges of the country, and to provide a platform for discussion and dissemination for the next generation of budding scientists, science educators, communicators and policy makers for India. I am hopeful that NERD shall reach unprecedented heights in promoting writing and discussing about contemporary science and science policy topics among students all across the nation through the new NERD HERD.

Ours is a developing country. The National Innovation Foundation (NIF) has declared 2010s to be the decade of innovation, the Prime Minister has announced that Indian R&D spending shall be increased from 1% to 2% of GDP in next half a decade, and CBSE and MHRD is bent on making educational reforms at school level. This knits the much awaited symbiosis between research, innova-

tion and education, which is being catalyzed by youth's addiction to entrepreneurship. One thing which still awaits a revolution in India is the status of science journalism and communication.

Coming back to campus events, another term that has been quite in air recently is 'Undergraduate Research'. Academic Review Committee (ARC 2009), IIT K recommended, in principle, promotion of research among undergraduates. Mr. N.R. Narayan Murty, Chief Guest, Inauguration Ceremony of Golden Jubilee Celebrations of IIT K, compared the research scenario and output of all IITs to those of western universities and gave examples how good universities abroad are very serious in involving undergraduates in research. Prof. Yash Pal, Chief Guest, Foundation Day, IIT K, started his address as "You all have the capacity and responsibility to bring about a much larger change than what you have brought about.", and mentioned later to the students, "Dive deep into a subject. Do not swim on the surface. Do not be a graduate labor."

It is high time NERD catches up with all these volatile messages and changes, and realizes its long term vision of a science magazine of the students, by the students and for everyone. NERD chapters should be started all over the country in various institutes thus inspiring an India-wide interest in research and development among the students. Better synergy of academia with industries and research centers would guide the technical development of the country in a way in which it has never been done before. Someone rightly said, "It can be no accident that there is today no wealthy country that is information-poor and no information-rich country that is poor and underdeveloped." Let us see NERD playing an instrumental role in seeing India 2020 vision of Dr. Kalam come true!

-Mohit Kumar Jolly
NERD

**CREATE,
COMMUNICATE,
CONTRIBUTE!!**



The Scientoon Man

Interview with Dr. P. K. Srivastava (A scientist and a scientoonist)

Scientoons & Scientoonics

a novel tool in science communication



Mohit Kumar Jolly and Utsav Kesarwani

*Dozing off during lectures is a common omnipresent phenomenon, especially if you find science to be dull and boring, and words like nanotechnology, spectrometry and metabolomics are Greek for you. It's time to meet Dr. Pradeep Kumar Srivastava, who has ushered in a novel **sleep resistant method** to deliver lectures and teach science. Dr. Srivastava, Senior Scientist at Central Drug Research Institute, Lucknow, has been teaching science through cartoons. Yes- you heard it right! He has explained the whole concept of DNA fingerprinting, spectrometry and many others all through cartoons, and only cartoons, which he calls as 'Scientoons' (www.scientoon.com).*

Dr. Srivastava has delivered over 680 lectures all across the world on scientoons on topics such as environmental pollution and its impact on human health, biodiversity, development of drugs, water conservation, nanotechnology, waste management etc. He was awarded the International Young Person of the Year by Junior Chambers Association (USA) [This award is given to 10 persons across the world annually]. He was also invited to present a paper on Scientoons in 32nd IUPAC Congress at Stockholm, Sweden by the Royal Swedish Academy and Swedish National Committee on Science & Technology. He was in IIT Kanpur on September 13, 2009 for delivering a lecture on Scientoons, and NERD team had the privilege to learn more about scientoons through an exclusive interview. Here are some of the excerpts:

NERD: Please tell us about Scientoons and Scientoonics.

Scientoonist: Cartoons are combination of caricature (distorted drawing) and satire (humorous comment). Scientoons are cartoons based on science that not only make you laugh or smile but also they convey lot of scientific information/data/researches/concepts in a simple, understandable and interesting manner. They are one generation ahead than other science cartoons (figure aside).


Each scientoon has 2 distinct parts- a box containing scientific information, data or new research results, and an attached cartoon, which makes entire information communicable to the audience. I coined this term on 26 May 1988, at the National University of Singapore (NUS).

Scientoonics is a new science which explains various science subjects and research areas using scientoons. It is a novel way of science communication.

NERD: How did the thought of inventing this new field come across you? What was your motivation for the same?

Scientoonist: I attended lectures and seminars by many scientists/researchers with a large number of publications & awards, but most of them were unable to hold the audience during their entire lecture and make it enjoyable, i.e., there was always a communication gap between the speaker (an expert in a particular area) and the audience (who may not have all experts), and this resulted in audience dozing off by the end of the lecture.

When I had to deliver my first lecture on 26 May 1988, I wanted everyone in the audience to understand and enjoy what I was talking about. My topic was very dull and comprehensive- Development of Drugs & Pharmaceutical Industry in Developing Countries. I thought to deliver my talk through a novel type of science cartoons to make it more interesting and impactful. The time I was allotted was 10 minutes, but to my surprise, the chairperson did not stop me and I continued for 45 minutes.

SCIENTOON	
<div style="border: 1px solid black; border-radius: 15px; padding: 5px; background-color: #fff9c4; display: inline-block;">Parasitology</div> Plants or animals which live in or on others and draw nutrients from them for their survival, are called Parasites and study of parasites is known as Parasitology	<div style="border: 1px solid black; padding: 5px;"> <div style="background-color: #c8e6c9; padding: 2px; font-size: 8px;">Department of PARASITOLOGY</div>  <p style="color: yellow; font-size: 24px; transform: rotate(-15deg); font-weight: bold;">CARTOON</p> </div>
<p>"See these Scientists! They exploit us for publishing research papers, getting Ph.D., attending seminars, visiting abroad and still they call us parasite?"</p>	

The lecture was well received and I won a silver medal for the best lecture. This was my first award and then I coined the term- Sciencetoon.

Later I switched to making sciencetoons related to areas of interest for the common man- pollution, global warming, climate change etc. and I earned more recognition & enthusiasm, and I continued making sciencetoons on a wide variety of topics. Now, whenever I design my lecture, I start thinking like a high school student, and then I follow a chain of sequence supported by sciencetoons to explain.

I am also working to animate these sciencetoons and writing books. My first book 'Sciencetoonic Tell-Tale on Genome and DNA' has already been published.

NERD: You have delivered more than 680 lectures all across the world in past two decades on alarming topics as global warming, drug research, water conservation etc. through sciencetoons. What vision do you have in mind for this field of sciencetoonics?

Sciencetoonist: Many times, the way science is being taught, it looks very technical, less interesting and sometimes even boring, and it is because of this reason that students across the world are opting for more lucrative career options in business, commerce and IT. This trend is an alarming one because no country can progress without development in science. My vision is to change the nature of science education in the world. I want to setup an international institution of sciencetoons to teach everything related to this field.

NERD: You have been working on science communication and popularization, and delivered lectures in India, Singapore, Thailand, USA and other Caribbean countries. How do you compare the present state of science communication and popularization in India than that with the other countries?

Sciencetoonist: India is not far behind - the government is paying attention and needs to encourage more people. A radical change in methods of education is required so that people enjoy science. Sciencetoons have also been included as a subject in the syllabus of M.Sc. (Mass Communication in Science and Technology) in many Indian universities-Lucknow University (Lucknow), Anna University (Chennai), Makhn Lal Chaturvedi University (Bhopal), Devi Ahilya Bai University (Indore) etc. Many other countries are also planning to introduce sciencetoons for science education and communication.

There are other modes of sciencetoons like plantoons, puppet sciencetoons and radio sciencetoons. India is leading the world in trying to communicate science with experts of puppetry for topics like HIV, hygiene, public health etc.

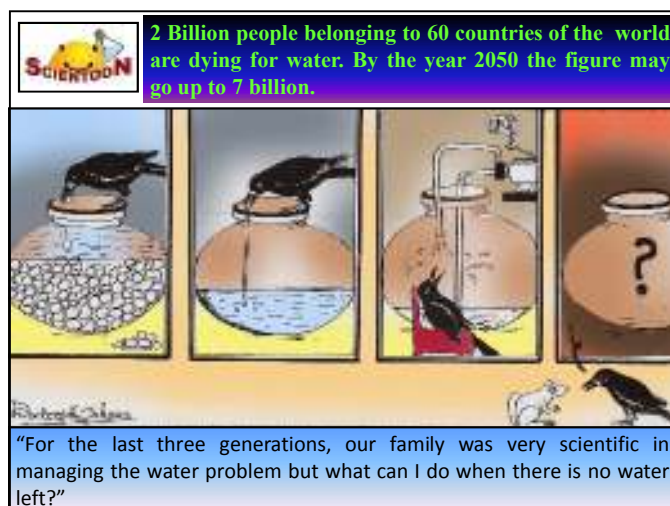
Sciencetoonics is also being aimed to teach advanced level topics like mass spectroscopy, DNA fingerprinting, nanotechnology etc.

NERD: WHO appreciated AIDS awareness and education to children through Sciencetoons. UNEP has published a report on sciencetoons for being used for environmental cause. How are sciencetoons being utilized so efficiently in such awareness campaigns?

Sciencetoonist: We need to educate not only the common masses, but also the policy makers sitting in government chairs. The theory of EA 2 (Education causing Awareness and Action) needs to be implemented well. For example, if we teach them about climate change and global warming, we make them aware and only after that, we can take necessary actions to protect the environment.

NERD: Your programs have been broadcasted on television on various channels Virginia 13-WSET TV (USA), National Network DD1 (India), Aaj Tak (India) etc as well as on radio channels like BBC (London) & All India Radio (India). Please tell us in brief about them.

Sciencetoonist: Water scarcity is an issue which shall affect everyone. On such topics, who doesn't need to be told and educated? It was a big challenge to make people visualise about this condition through radio within a four-minute program. I gave a scenario of water scarcity and urgent need for its conservation, and told the story about the crow that died and told the frog to put pebbles in a pot (Refer: the Sciencetoon below).



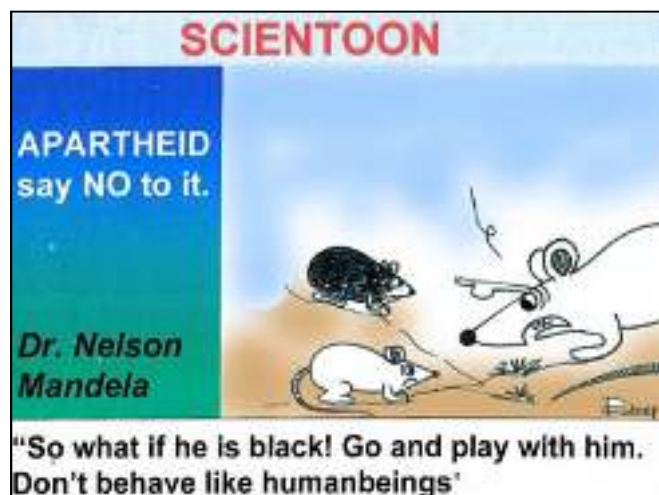
To convert it into a radio sciencetoon, I with my colleague, Ms. Khare, Program Executive of All India Radio (AIR), Lucknow, called few students and started reciting 'ek kauwa pyaasa tha' (A crow was thirsty) on radio. The Deputy Director and his fellows at AIR, Lucknow started mimicking the recital in voice of a crow. This program was broadcasted through all the 210 stations same day same time and it gained a great response from listeners.

NERD: Amongst all the lectures given by you, what was the most challenging topic you feel & why?

Scientoonist: The most challenging one was mass spectrometry as the topic is very technical.

NERD: Please share with us about some of your scientoons you are deeply attached to.

Scientoonist: The one I am deeply attached to is on 'Apartheid', that received appreciation from Hon'ble President of India Dr. Abdul Kalam as well. (Refer: the Scientoon below) and there are two reasons for it.



Firstly, when I was honoured as the most outstanding person in America, this was the cartoon which was displayed and all the 800 - 900 black people who were present at the ceremony well appreciated this. Secondly, when in an award ceremony, I was moving amongst the crowd of more than 4000 people of a Puerto Rico, a Caribbean country, a girl came to me and requested me to make the same cartoon. By the time I finished, she started touching me saying that she wanted to catch that something special in me. This was the biggest complement for me. This event also taught me the biggest lesson of my life- 'Never judge a person by his appearance'. I also made the same cartoon in the VIP book of American Airlines and Air India.

NERD: You were invited to European Science Festival 2008 to give a talk on Scientoonics and we heard that you were struggling for your trip to get sponsored. What does this speak of the development, awareness and attitude towards the field in India?

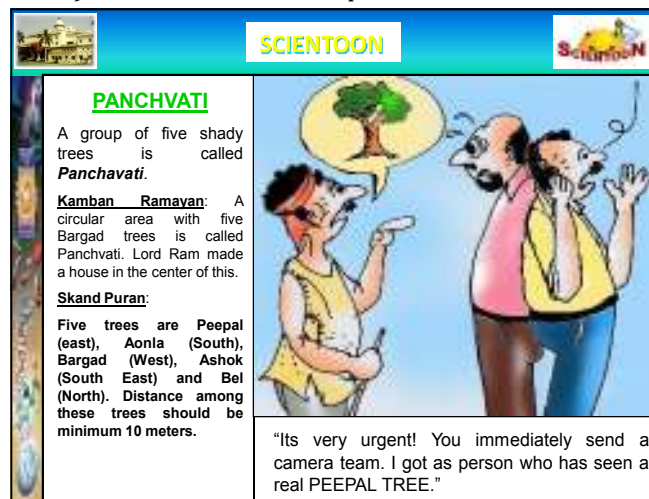
Scientoonist: July 3, 2008 was the great moment for me when I was invited to the European Science Festival with 25000 scientists from all over the world. I was allotted 90 minute session in the festival, but they could not sponsor my trip. I felt very depressed. USA supported everyone from its country, but I could not get any sponsorship from the institute or government. Finally, Dr. Manoj Patariya (Director, National Council of Science and Technology Communication, Department of Science and Technology) went there through support from Government of India and gave the presentation.

NERD: You also propose to set up an international institute to promote science education through visual media by bringing science graduates, cartoonists and communication experts on a common platform to generate tools for simplifying science education. What are the updates regarding the plan?

Scientoonist: Yes, it is my dream plan. I am in touch with many people in world related to same field to set up this institute with head quarters in India and branches everywhere. The Government of India should provide help for this cause. A medium is required to convey the information to and from experts in a simple way.

NERD: You have a galaxy of awards at your name- the Outstanding Person of the Year by Junior Chamber International (USA), Distinguished Leadership Award by American Biographical Inc. (USA) and International Brand Ambassador of the Young Scientist. What, in your opinion, has been your most significant contribution to science communication and popularization in India and outside India?

Scientoonist: I am very happy to see when people not having any science background understand tough subjects with the help of scientoons. Also these scientoons influenced government to make reforms, for example, a scientoon on 'Panchavati' influenced the government to sanction 1.5 crores to various districts of UP to plant those 5 trees along with *neem*. (Refer: the scientoon below). I think one must be expert in communication.



Scientoons have also played an important role in solving common public issues. For example, garbage in Lucknow was carried by uncovered trucks, and a truck driver driving at 50-60 km/hr was dumping garbage throughout the city. I spoke to many government officials in my talks about the problems arising due to them. On 5th June 2009, I told the Mayor of Lucknow Dr. Dinesh Sharma about this menace, and within a week, all trucks were covered properly.

NERD: You also received the National Award for Science Writing by ISWA (Indian Science Writers' Association), and have been appointed by DST (Department of Science

& Technology) as an expert to conduct science journalism workshops throughout the country. How, in your opinion, the concept of a student science magazine, like NERD, can contribute to the current situation of science communication?

Scientoonist: I am deeply impressed with the idea of NERD. It is the need of the hour that the younger generation comes forward to solve the problems of science communication in our country. You should include more visual content in NERD to make it interactive. A regular column on scientoons matching with the theme of the issue can also be helpful in communicating science to non-experts and elaborating author's talent as well.

NERD: Being a shy child from Rae Bareli & now a senior scientist in Chemical Division of Central Drug Research Institute (CDRI), Lucknow and popularly known as the Scientoon Man, how would you describe Dr. Pradeep Srivastava in one line?

Scientoonist: I will never forget my roots and continue to struggle hard to popularize science and scientoonics and learn from everyone I meet.

“ I will never forget my roots and continue to struggle hard to popularize science.”



NERD: What is your final message for the readers?

Scientoonist: Have confidence in you as you all can create the best in world, never give up even if you fail, have patience to bear failure. Learn from the mistakes and come back to your job.

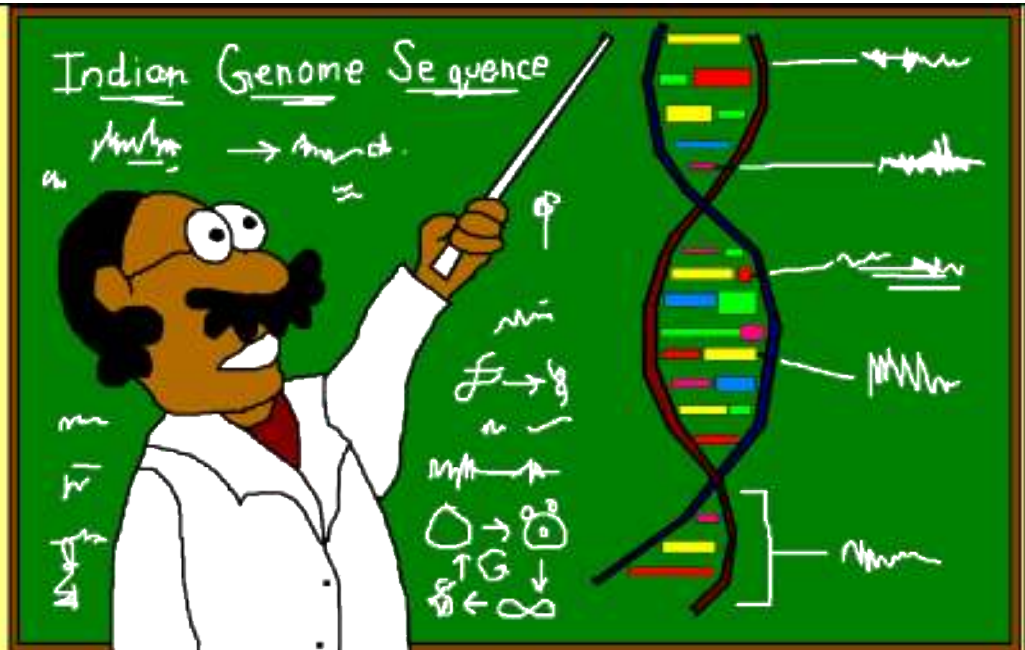
Mohit Kumar Jolly (mkjolly@iitk.ac.in) is a final year undergraduate at IIT Kanpur. He is interested in science journalism and communication, and is the Co-founder and Student Coordinator, NERD.

Utsav Kesarwani (utsavk@iitk.ac.in) is a second year undergraduate at IIT Kanpur and member, NERD team.

SCIENTOON

Puneet Singh, NERD Team member

Scientists at the Institute of Genomics and Integrative Biology (IGIB) in Delhi have successfully mapped the Human Genome Sequence for the first time in India. The project took two years of background work — setting up a supercomputer facility, procuring software and standardizing protocols. The team that achieved the feat was led by Dr S Sridhar and IGIB PhD student Vinod Scarla, both in their mid-thirties. Though some scientists thought it wasn't such a big feat and anyone with a machine could do it, the event itself stood out as a stepping stone for more Indian genomic studies to come.



“This gene makes Indians like cricket. This one makes the taste buds crave spices and masalas. We think that this gene addicts women to TV soaps starting with the letter ‘K’ and men to celebrity reality shows”

The Re-discovery of India



Vikas Trivedi

"...this edition of mine and the translation of the Vedas, will hereafter tell to a great extent on the fate of India and that a large number of Vedic hymns are childish in the extreme; tedious, low, commonplace. They (the Vedas) contain, by the side of simple, natural, childish thoughts. India has been conquered once, but India must be conquered again and that second conquest should be a conquest by education...the ancient religion of India is doomed, and if Christianity does not step in, whose fault will it be", Max Muller wrote in his letter to Duke of Argyll, Secretary of State for India in December 1868. The following article shall bring to light some facts which shall question the above statement vehemently.

It had been about one hour since the sun had hid itself behind the horizon. The canopy of darkness was slowly veiling the surroundings. It's the month of October, 1962 and Dr. Brij Mohan, Head of the Department of Mathematics, BHU, Varanasi, is working in his office. Suddenly he hears a knock on the door. He stands up from his chair, comes to the door but no body is there. He assumes that it was a gush of wind that made the sound. As he turns back he hears the sound again. He turns immediately and swings open the door. He finds a lady, wrapped in a khaki shawl standing on the door with her eyes peeping through the spectacles. Before he could ask anything the lady enters into his office and puts down a pile of papers that she had been covering under her shawl, on his table. The lady whispers something into his ears and immediately leaves the place. Dr. Mohan, totally confused, goes near the pile, picks up a sheet and sinks down in his chair.

Two years have passed since then but Dr. Mohan has never been at rest. He has been examining the manuscript that was handed over to him by Smt. Manjula Trivedi, the lady who visited his office. Nobody knows what do those papers have in them but one thing that everyone has noticed is that Dr. Mohan is at unease. Five

days are left for June to start and Dr. Mohan struggling in his office with those papers. He orders his peon for tea and himself switches on the radio. The very first news he hears is about the death of the nation's first prime minister. He is taken aback and sinks in his thoughts deeper than ever before. The light of the setting sun entering his office is diminishing and as the twilight is fading gradually the image of bulbs inside appearing in the window glasses of his office have started interrupting the view of quiet and green campus outside the Mathematics department. Time is passing and it's almost ten, but Dr. Mohan is still in his office.



Suddenly he stands up, puts on his glasses, comes out and latches the door behind and starts walking towards north. He reaches the campus gates and now he could see the statue of Pt. Madan Mohan Malviya, founder of BHU. He bows slightly and beckons a rickshaw puller to take him to the Dashashwamedh Ghat on the banks of Ganges. Everything is silent and clam on the banks yet the silence appears to be mysterious. Dr. Mohan looks around : the rickshaw puller is gone, there is no body around, it's complete darkness, except at some distance he can hazily see the smoke swirling up from the reddened logs of woods put in a 'Chita' that must have been lit a few hours ago. He decides to move in that direction.

When he is about a score of feet away, he sits down on the bank and starts contemplating. The images of those manuscripts are still haunting his mind. "I know what has kept you disturbed through all these years" a soft voice broke the silence that was hovering the firmament a moment before. He sprang up with astonishment only to realise that the voice belonged to the same lady who had handed over the manuscripts to him.

"I know Mohan ji that the calculations and the solutions proposed in the manuscript that I handed over to you have really disturbed you" Manjula continued, "because it is very difficult for a western mind or ones trained in those ways to believe that Indian tradition that can be traced back to even before 8000 BC, gave to the world much more than the sign of zero. It is much less known that important concepts like that of recursion, algebraic transformation, mathematical logic, abstract language description, binary numbers, combinatorics also arose in India several centuries before their rediscovery in the West. Indian mathematical science had already reached dizzying heights about 2500 years ago by the time of *Panini* and *Pingala*. *Panini's* grammar for Sanskrit, which is equivalent in its computing power to the most powerful computing machine, has not yet been matched for any other language, while *Pingala* described the binary number system." As she was speaking it seemed to him as if he was witnessing a mysterious revelation from a chiromancer who could apprehend all that was within him.

"*Shruti* was the method of memorisation of the vedic text and its transmission from one generation to the other with high fidelity. Vedic literature comprise of the four Vedas: *Rig*, *Yajur*, *Sama* and *Atharva*. In addition it also consists of *Vedangas*, *Purana*, *Upanishads*, *Upvedas* (*Ayur*, *Dhanur*, *Gandharva*, *Sthapatya*). Ancient sages i.e. the *rishis* used to memorise up to 11 forms of recitation of the same text which were subsequently "proof-read" by comparing the different recited versions. While ***Jaṭā-pāṭha***, literally meaning "mesh recitation", would have the sequence of words recited as 1-2, 2-1, 1-2; 2-3, 3-2, 2-3the ***Dhvaja-pāṭha*** (literally "flag recitation") for a sequence of N words would be 1-2, (N-1)-N; 2-3, (N-3)-(N-2); ...; (N-1)-N, 1-2. The most difficult was the ***Ghana-pāṭha***, literally meaning "dense recitation, which was recited as 1-2, 2-1, 1-2-3, 3-2-1, 1-2-3; 2-3, 3-2, 2-3-4, 4-3-2, 2-3-4; That these methods have been effective is

testified by the preservation of the most ancient Indian religious text, the *Rigveda*, as a single text, without any variant readings."

"The Indians had adopted the decimal scale very early. The numerical language of no other nation is so scientific and has attained as high a state of perfection as that of the ancient Indians. In symbolism they succeeded with ten signs to express any number most elegantly and simply. The Hindu notation was carried to Arabia about 770 AD by a Hindu scholar *Kanka* who was invited from Ujjain to the famous Court of Baghdad by the Abbasid Caliphate *Al-Mansur*. *Kanka* taught Hindu astronomy and mathematics to Arabian scholars and with his help they translated into Arabic the *Brahma-Sphuta-Siddhanta* of *Brahma Gupta*. From Arabia, the numerals slowly marched towards the West through Egypt and Northern Arabia; and they finally entered Europe in the 11th century. The Europeans called them the Arabic notations, because they received them from the Arabs. But the Arabs themselves, the Eastern as well as the Western, have unanimously called them the Hindu figures (*Al-Arqan-al-Hindu*)."

Dr. Mohan was still listening when Manjula stood up, walked a little away and then returned back with a small stick in her hand. With the stick she drew up something on the sand to which Dr. Mohan immediately shouted "It's a trapezium, but what do you want to prove by this?". "Have a little patience Mohan ji" she sounded mysterious, "this is a figure which is widely used in making the *Yajna vedi* or the altar, but have you or anybody ever paid attention to what is the significance of its shape?"

The answer to this question was obviously not affirmative and so with a smile on her face she continued. "The isosceles trapezium used in *yajnas* had specific dimensions which you can see on the figure as I am drawing them" And with the stick she drew 5 variations of the same figure and in all of them she showed perfect right angled triangles (Figure1). "So do you want to prove to me that Indians knew about the Pythagoras's theorem? Making a few triangles that satisfy Pythagorean triplets doesn't prove anything." Dr. Mohan immediately reacted. "I said Mohan ji, have a little patience. For your doubt let us see what exactly the vedic text has to say about right angled triangles."

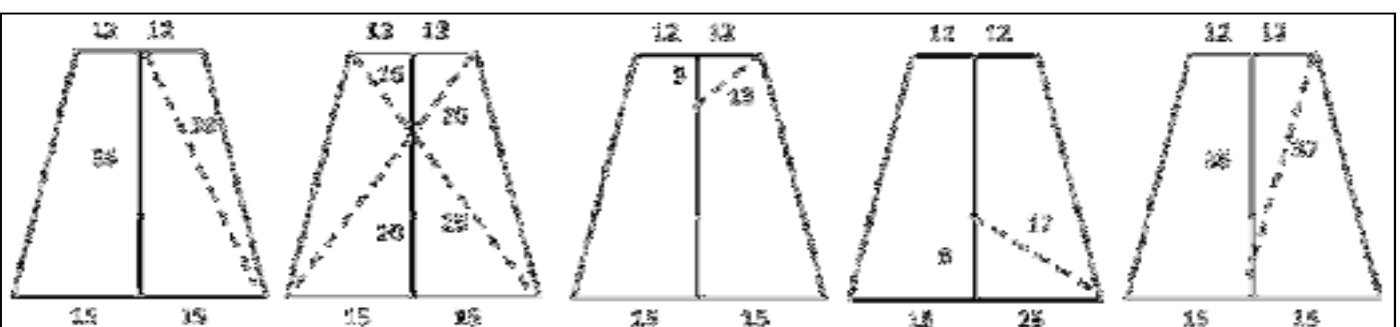
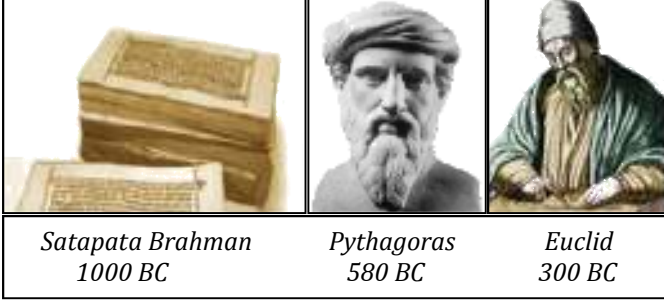


Figure 1 Isosceles trapezium used in the *Yajna vedi* or the altar

She was now drawing a rectangle with three squares, two on its sides and one on the diagonal (Figure 2a). "The *Satapata Brahmana* says that the sum of areas of two squares drawn on the sides of a rectangle is equal to the area of the square drawn on the diagonal of the rectangle. Now this is the same proof which appears in Euclid's book "*The Elements*". And we also know that Pythagoras lived around 580 BC and Euclid around 300 BC whereas *Satapata Brahmana* was written around 1000 BC. Do I still need to say anything Mohan ji?"



All this had bewildered the professor. He was trying to make out everything when all of a sudden she said :

योजनाम सह वे वे शते वे च
योजने एकेन न मश्म मण नमोतेत।

"Do you know what is this Mohan ji that I said just now. It is a hymn from Rig Veda in praise of the Sun God. The author says that he bows before the Sun God whose rays travel 2202 *yojans* in half *nimish*. When you convert these to modern units where a *yojan* is 29.261m and a *nimish* is 0.4256s, you get the modern speed of light correct to two decimal places."

1 Yojan = 29.261 m (Narada Puran 4-2-5,6)

1 Nimish = 0.4256 s (Srimad Bhagwatam 3-11-3, 10)

2202 yojan/ (0.5 nimish) = **2.99346 x 10⁸ m/s**

Present Value = 2.99792458 x 10⁸ m/s

"It is a matter of historic interest to note that in their mathematical writings the ancient Sanskrit writers did not use figures when big numbers were concerned in their numerical notations but preferred to use the letters of the Sanskrit *Devanagiri* alphabet to represent the various numbers! *Katapayadi Sutra* (Figure 2b) was such a system wherein consonants represented various numerals and possessed the powerful ability to form easily

memorable words through the insertion of vowels between them. Meaningful and mnemonic words could now be formed using these letters in much the same way as mnemonic words are coined today to represent commercial telephone numbers.

The use of it is very apparent in the South Indian musicology. All Janaka ragas were named following this sutra. *Katapayadi* translation of first two syllables of its name gives us its number which indicates the sequence of notes, for example in the *Mechakalyani Rag* : the syllables *Me* and *Cha* give 65 which now enables to go directly to the raga's position in its table from its name without having to do any search. To give you a better feeling of *Katapayadi Sutra* let me recite a *shloka* to you

गोपीभा यमधु त्रृगोशोद धसं धका खि ज वताखाताव
गलहालास घर॥

When you decode this with the help of the *sutra* do you have any idea what will you get ? You get the value of $\pi/10$ correct to 32 decimal places i.e 0.31415926535897932384626433832792"

All this was making Dr. Mohan witness a metamorphosis of himself. Before he could speak anything, Manjula broke the silence again "Mohan ji, these are just a few examples that I have quoted to give you a glimpse of the knowledge that is contained in the Vedic literature. The *Chhandashastra* or "the science of verse meters" written by *Pingala* in 4th century BC highlights the methods of constructing *prastaras* (Figure 3a), which are equivalent to the truth tables. A Sanskrit meter consists of verse feet which are composed of syllables which are prosodically either light (*laghu*) or heavy (*guru*). A light syllable consists of a short vowel followed by at most one consonant and any other syllable is heavy (Figure 3b). Using these *guru* and *laghu* syllables *Pingala* constructed the *prastaras* and using a value of 0 and 1 for them respectively he describes the method of converting decimal numbers to binary and vice versa. (Figure 3c) *Shlokas* like

उ तम वृषान अ कान उपर आ यात समा लखेत
लघु थाने तुये काह सू तैः सेकेर म तीर भवेत्त

are the ones where he describes the entire process elaborately."

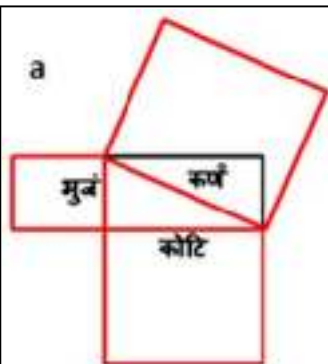
a		b	१	२	३	४	५	६	७	८	९	०
		कादि नव	क	ख	ग	घ	ङ	च	छ	ज	झ	ञ
		टादि नव	ट	ठ	ड	ढ	ण	त	थ	द	ध	न
		पादि पंच	प	फ	ब	भ	म					
		यादि अष्ट	य	र	ल	व	श	ष	स	ह		

Figure 2 (a) Proof of Pythagoras's theorem in *Satapata Brahmana* (b) *Katapayadi Sutra*

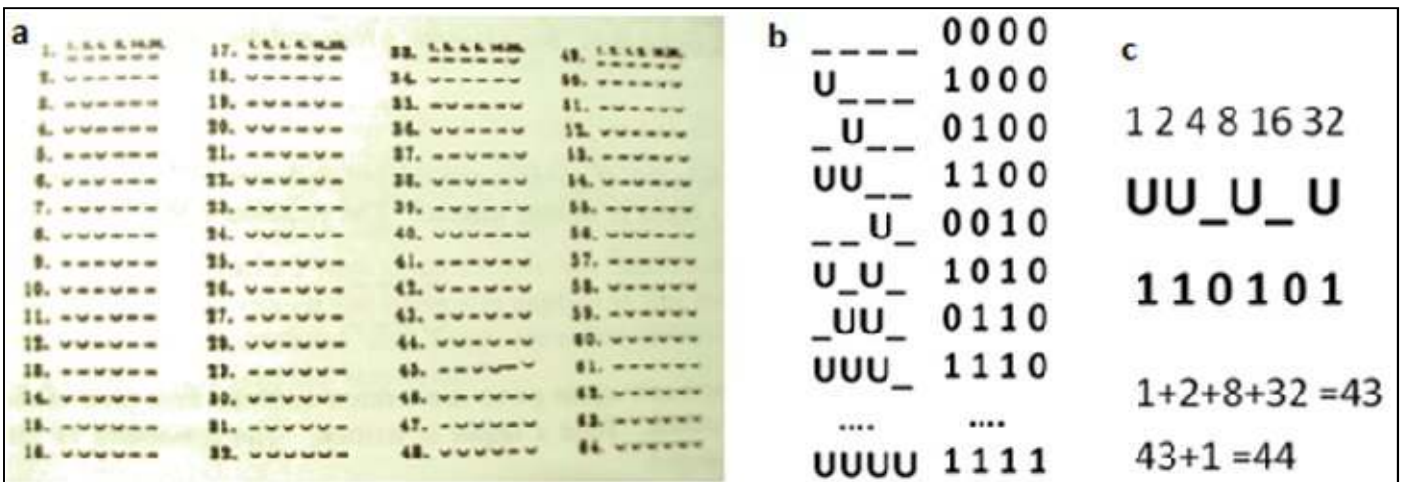


Figure 3 (a) Prastara (b) Construction of 4 digit binary numbers' prastara (c) Conversion of Binary to decimal number using Pingala's method (U= laghu, _ = guru)

"Mohan ji the point that I am trying to make is a very simple one. Our history has been written and taught in the way western historians have understood and framed it. But evidences stand out and demand that we need to reconsider what is being considered at present.

She continued, "I just want you to leave with the message that it is unfortunate that this approach has not been questioned more, particularly by Indians. Many Indians still accept, read or even honour the translations of the 'Vedas' done by such Christian missionary scholars as

Max Muller. Would modern Christians accept an interpretation of the Bible or Biblical history done by Hindus aimed at converting them to Hinduism? Universities in India also use the Western history books and Western Vedic translations that propound such views that denigrate their own culture and country."

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Student initiatives recognized- NERD & ICARUS

Mohit Kumar Jolly (Co-founder and Student Coordinator, NERD) presented a paper on 'Catalyzing science communication through students' at the 6th International Conference on Hands-on Science (HSCI 2009) held at Ahmedabad (India). The concept of NERD was presented as a student initiative to celebrate the work done by students and encourage discussions among them, introduce students to science writing and communication and bring research from journals and shelves to everyone in a comprehensible way. The presentation received a huge response and many delegates expressed their wish to contribute to NERD. (In this issue, you will find 'Role of paper toys in eradication of insect phobia in a community' by Dr. VSS Sastry, one of the delegates of HSCI 2009).



ISCC (Indian Science Communication Congress) 2009, held in Guwahati, also witnessed a presentation on 'Using science communication to promote student research' by NERD team members- Bhuvnesh Goyal and Mohit Kumar Jolly. They talked about two student initiatives at IIT Kanpur- NERD and ICARUS'2010 (Indian Conference for Academic Research by Undergraduate Students 2010), that were aimed towards promoting involvement of students in technical research and development activities.

Golden Jubilee Organizing Committee, IIT Kanpur accepted the proposal for conducting the first national level undergraduate research conference (ICARUS) as a part of Golden Jubilee Celebrations at IIT Kanpur. ICARUS'2010 shall be held from March 26 - 28 March, 2010 at IIT Kanpur, and its theme is 'Undergraduate Research'. The events are Sanshleshan (Paper presentation contest), Adbhut (Poster presentation contest), Joojho (Brainstorming session) and Margdarshan (a lecture series by eminent dignitaries). The first ICARUS will be graced by the presence and keynote lectures of Dr. R. Chidambaram (Principle Scientific Advisor to the Government of India), Dr. R. Narasimha (foremost Aerospace scientist and world-renowned fluid dynamicist) and Dr. K. A. Natarajan (Honorary Professor at IISc Bangalore). Kirtimaan Mishra (kirtiman@iitk.ac.in) is the Convener, ICARUS' 10.





Felixologue

Control of exoskeleton robots for rehabilitation of stroke patients

M Felix Orlando

Recent research shows that stroke patients who lose their ability to control their arms/legs can recover a fair amount of their brain functions (plasticity) if regular physical therapy is provided. There is a dire dearth of trained physical therapists for the large number of stroke patients across the world. The following article talks about using robotic therapists (exoskeletons) - designing an optimal wearable robot hand that can provide the physical motion to a stroke patient's hand, thus stimulating the brain cells for regeneration. This exoskeleton hand would use EMG or (Electromyography) or EEG (Electroencephalography) signals obtained from the patient using a BCI (Brain Computer Interface). How can an optimally designed finger exoskeleton replicate human therapist's motions and tune the therapy in a smart and intelligent way based on rate of recovery of the patient, let's read and find it out.

Introduction:

Recent progress in robotics technology has brought about a revolution in its non-industrial applications like rehabilitation, agriculture, surgery, entertainment etc. A lot of current research is being addressed towards human welfare for restoration of motion of the arms or legs of elderly or disabled persons. Robots have been designed for assisting in feeding, walking, sitting, and day to day care of elderly. It has also been predicted that as the world population ages and life expectancy increases in most countries, the need for assisting robots will become more and more. Most of the early applications of exoskeletons (wearable robots) were as man-amplifiers or power assist suits and their applications were for military purposes. More recently the focus has shifted to human assistance; most famous suits developed in the last few years are HAL and Bleex.

HAL (Fig. 1) is an exoskeletal suit that the wearer uses to augment his physical strength. It has motors located at the joints that are actuated by using the neural signals from the wearers' muscles. HAL has the hybrid control systems which consist of the autonomous controller such as posture control and the comfortable power assist controller based on biological feedback and predictive feed forward. Bleex is a wearable human amplifier mainly for use by soldiers to carry heavy loads. The major thrust of research in this area has been restoration of locomotion or arm motion by using Functional Electrical Stimulation (FES) or for paraplegic pa-

tients. Past research on restoration of grasping function in paraplegic or stroke patients is rare and hence in this research we propose an exoskeletal robot for human three finger grasping support - design, sensor fusion and control. The developed exoskeletal will generate flexible human like motion based on biological signals derived from the EMG/EEG signals that directly reflect the subjects intention. The developed device can be used for the following three cases a) to support the fingers of elderly persons who have reduced control over their finger force, b) active hand prosthetics for persons who have lost their fingers and c) rehabilitation of patients with finer injury/ neuro muscular disease.



Fig. 1 HAL (Human Assistive Locomotion made by Univ. of Tsukuba, Japan)

Human finger motion capture and optimal finger exoskeleton design:

The human hand has almost 20 degrees of freedom and the joints are not all simple revolute joints (also called pin joint or hinge joint). Hence the kinematics of grasping and manipulation is still not very clearly understood. Due to this it is very difficult to design a robot hand for physical therapy that can accurately emulate the motion of the fingers. Our first task was to study the finger motion and then try to optimize a robotic mechanism that can replicate human motion of grasping. Each link in the finger was replicated by a 4-bar mechanism. Three triangle shaped markers denoting a coupler triangle of the 4-bar mechanism with the three ends marked with Red, Green and Blue color dots were placed on the lateral side of the finger as shown in Fig. 2.

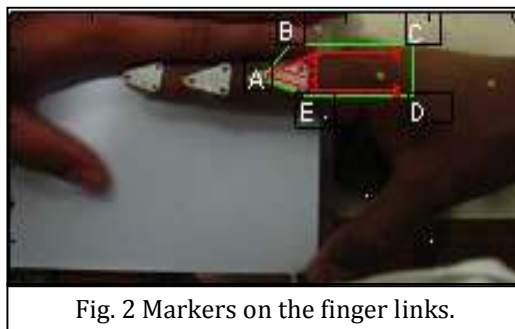


Fig. 2 Markers on the finger links.

A human subject was asked to perform the Flexion motions (bending motions resulting in the decrease in the angle between the two parts) of the three joints MetaCarpophalangeal (MCP), Proximal InterPhalangeal (PIP), and Distal InterPhalangeal (DIP) and these motions were recorded using a single camera, as the finger was moving in the flexion plane alone. The camera was mounted vertically above the finger so that the top view from the camera has been observed. The corresponding phalanx marker trajectory was computed by a customized MATLAB program. Then the coupler points of the marker trajectory were given as input for the three position synthesis of the 4-bar mechanism. Optimal 4-bar mechanisms representing each joint, for the human index finger were synthesized using Genetic Algorithm, based on the path generation method. The main reason for considering the 4-bar mechanism is that the instantaneous joint centre of the human finger joints cannot be represented by simple revolute joints. Conventional three-position synthesis of 4-bar with specified fixed pivot positions has been used. In effect, four free choices i.e. the x and y co-ordinates of the two pivots, instead of the joint angles of the links have been taken. This approach will lead to a set of non-linear equations containing transcendental functions of the unknown angles. Once the angles have been obtained, the set of four dyad equations can be solved for four unknowns representing the vectors of the dyads. The Optimal 4-bars based exoskeleton developed by Rapid Prototyping and actuated by ultrasonic motors is shown in Fig. 3.

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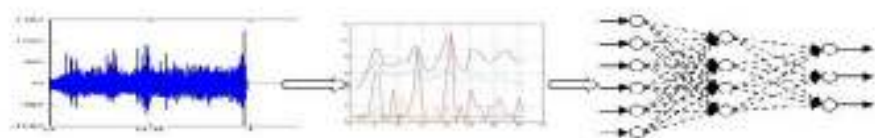


Fig. 4 (left) Electrodes fixed on the two sides of the arm, (right) EMG signal extracted, feature extraction, training neural

Control using human EMG signal:

Surface EMG signals were extracted from the arm muscles, processed and then used to control the finger exoskeleton to move along with the finger. Two electrodes were placed, one on the Flexor Digitorum Superficialis muscles on the anterior side and another on the Extensor Indices on the dorsal side of the forearm as shown in Fig. 4. Three male subjects in the age group of 20 to 30 years voluntarily participated in the EMG extraction process. The subject was asked to move the index finger to the maximum flexion and extension positions and finally relax back the finger. The subject was then asked to flex the finger in 15 degrees increments, with an approximate constant velocity (15 degrees was covered in 5, 4 and 3 seconds respectively) and keep the finger in that position for the next 5 seconds. This process continued until the maximum flexion position was reached. Then the subject extended the finger in a similar fashion up to the initial position. The EMG signals were recorded during the whole process.

The features measured for each of these observations were Root Mean Square, Wave Length and Discrete Fourier Coefficients. Each of these features was then normalized corresponding to the features measured for maximum flexion readings. For feed forward MLP these features were used as it is, while for RNN the difference between current feature values and the features from previous observation were used. For each of these observations, a set of desired output was obtained from the experiment. These outputs were: a) *Flexion/Extension/Rest*: Whether the finger was undergoing Flexion or Extension. b) *Angle*: Current angular position of the finger (from 0 to 70 or 85 deg). c) *Velocity*: Velocity of motion of finger. (Constant value during motion and zero during rest). Thus, the features and the labels constituted the patterns given to the artificial networks for learning. Also, since temporal variations EMG signal was provided and not the EMG parameters as input to the network, the variation of EMG signals with change in the states of finger motion could be learnt better. Using the learned relation between the input EMG and the finger angle the exoskeleton was controlled.

Experiments on exoskeleton control using brain EEG signals:

All motor actions like walking, arm movement, grasping etc. originate in the brain and then performed by muscles via the neural system, hence the best way to control any exoskeleton would be to tap the signals right from their origin in the brain. This is of course easier said than done as the brain signals are very weak and are produced inside the brain and are difficult to tap using external electrodes. We are currently analyzing brain signals to try to learn how the brain signals the arm and finger to perform certain tasks. An external cap with electrodes is fitted on a subjects head and he imagines performing various hand and finger motions, without actually performing them, as shown in Fig. 5. The signals are recorded analyzed and then a mapping created between the signal and the corresponding motor action. Once the mapping is established the signals can be used to control the exoskeleton. We are still struggling at understanding this mapping!

Conclusion:

Robotics has come a long way from being dumb industrial machines to helping patients and in rehabilitation (stroke, paralysis, disease, etc). This article described an attempt being made to design and control exoskeleton robots for serving humans better. With the world population aging at a fast rate it is imperative that such robots will become more and more popular. Apart from simply

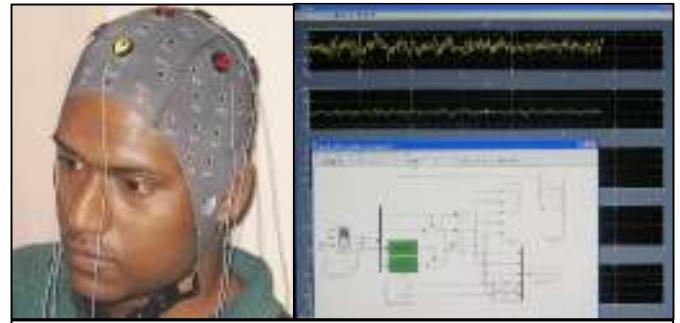


Fig.5 Electrode cap fitted on the subjects head and the corresponding signal extracted from the brain.

studying brain signals and their use in robots, an understanding of brain signals will lead us to discover more about our own thinking, learning process and ultimately our own existence. As in the movie 'MATRIX' ultimately everything is an electrical signal or is it?

M. Felix Orlando (mfelixor@iitk.ac.in) obtained his Masters from the Intelligent Robotics Lab in the Korea Institute of Advanced Science and Technology, Korea. He is currently a third year doctoral student in the Department of Electrical Engineering, IIT Kanpur under the guidance of Profs. Ashish Dutta, Anupam Saxena and Laxmidhar Behera. This article is the first in line for his column Felixologue. His research focuses on the design and control of exoskeleton robots using EEG and EMG signals for rehabilitation of stroke patients.



Encouraging 'Hands on Learning'

Vamsee Krishna, Yardstick

Each parent wants his children to opt one of the set of the professions that would be lucrative and prestigious, and in this rat race process, many a times children's desires, imagination and creativity all remain stunted. Going beyond the textbook and exploring the world beyond empowers the children and assist them in every sphere of their life, that is the thought behind formation of Yardstick (www.yardstick.co.in).

We are living in times when everything around us is changing—the very way we live, think and communicate. We are currently witnessing exciting innovations in the learning sphere as well.

As students, all of us have felt the need for more freedom to explore our world the way we want and understand. But more often than not, our environment doesn't allow us to explore beyond a certain limit. This limitation may be at all levels of our society—home, school or outside. We are bound by do's and don'ts that stunt our imagination. As we grow, we attain academic qualifications, well paying jobs and a many other things, but deep inside, there is an urge to do something different and take the unbeaten track. The first step is to listen to the inner voice and take the plunge—then comes the contentment and the sense of achievement.



To share my own experience as to how we have become successful entrepreneurs today brings back fond memories– the ups and downs of setting up a company, the joy of seeing it grow, forging new relationships and new ideas. We initially left our good paying jobs to start Yardstick, as we strongly felt that the current educational system needs better assessment platforms. We later realized that what was required was more than just a good assessment system– we required to focus on the whole learning methodology. There is a huge gap at present that we need to bridge, to transform dreaming children into youngsters who can nurture their dreams and turn them into reality. It was during this time, we understood that children need to be empowered and given opportunities to explore beyond the textbook and go on to understand the world around them by exploring, experimenting and questioning.



We have since then transformed Yardstick into a completely child oriented company, developing 'Hands on Learning' methodology for children of all ages. Though we have a long way to go, I am happy that we were able to understand and also had the commitment to see our vision through.

When we started the organization, we had a good idea and we had the vision to take it forward, but within a short while, we realized that the idea needed to be backed up with strong financial plans as well. We needed to make our ideas translate into financially viable investments and that was a big challenge for us, as none of us was from a management background.

One of the lessons we learnt over time is to have a strong vision statement and an action plan to achieve it. Attracting talent and retaining employees has become easier once we were able to articulate and create examples of this shared vision.

Today we are at a position where we have many individuals influencing our society and motivating us to dream bigger. Looking at the positive growth and the way the child starts looking at the world around him when given an opportunity to learn on his own, we have been backed by a number of people in the learning industry and academicians to take our initiative forward to children across different societies.

Now, we are focusing on developing teaching and training modules, learning aids and teaching aids in the form of toys and games to facilitate a better learning experience. We are working to make 'hands-on-learning' an integral part of curriculum at the school level. Over a

period of time, we want to set up cost effective models wherein schools in rural and semi-urban areas can also experience this joy of learning.

Just to give an insight into what has made us successful, I would like to share our philosophy and objectives of our programs.

Most of our programs have the following philosophy:

- Science as a process of inquiry
- Students are actually allowed to perform science as they construct meaning and acquire understanding.
- Activities focus on core concepts, allowing students to develop thinking processes and encouraging them to question and seek answers that enhance their knowledge and thereby acquire an understanding of the physical universe in which they live.
- Students are presented with problem-solving activities that incorporate authentic, real-life questions and issues in a format that encourages collaborative effort, dialogues and generalization to broader ideas and application.

Learning Objectives:

- Better understanding of science concepts– lesser time to learn them and they remain embedded for ever
- Applying the concepts to real life situations
- Evaluating the given situation in a scientific way
- Synthesizing Solutions for real life problems

Auxiliary Objectives:

- Higher Order Thinking Skills
- Scientific Methodology / promotion of Scientific Temper
- Creativity and Design Skill
- Better Communication and Team Skills

Course Structure (On Skills):

- Following the Instructions
- Trouble Shooting
- Innovating
- Integrating
- Designing
- Creating

We believe that we have taken the right step towards redesigning how children are currently taught in our country. We believe in a partnership of education, learning and innovation, and have realized that the child is our end customer and that we need to focus on delivering him a complete and enjoyable learning experience. We are investing in our tomorrow, in the future of our country.

Images used in this article have been taken from:

1. <http://sundararajan.sulekha.com/albums/bydate/2009-07-01/slideshow/263400.htm>
2. <http://www.buzzle.com/img/articleImages/282125-781-3.jpg>



Sriram G.

Introduction

An open ended problem statement on making an autonomous ground vehicle within a dimensional constraint of 1 feet was floated among the student community and proposals were invited last year in the month of January. After two rounds of selection, a group of eight second year undergraduates were selected for realising their model by a judging panel. The objective of the project is making a small autonomous robot which can operate in an alien environment with minimum operator intervention.

What is an autonomous robot?

An autonomous robot is defined as a robot that can perform desired tasks in highly unstructured environments without human intervention, saving itself from all the hazards that it may face during its execution. Such a robot can be of great use to human personnel working in hazardous areas such as urban military combats, deep mines etc. and can work in a much more safe and efficient manner than humans. In a nutshell, it is an independent agent capable of promoting its own welfare. However, developing such a robot is a complex problem and we have to clearly define our purpose and the level of autonomy that we wish to achieve in our vehicle.

State of Art in this area

The first mobile robot to use intelligence to control its actions dates back to SHAKEY developed in Stanford University in 1969 by Nils Nilsson which could navigate through indoor structured environments such as office buildings. Since 70's, research has been going on increasing the autonomous functionality of unmanned vehicles. Notable development in the 1970s is the Jet Propulsion Laboratory Lunar Rover designed for planetary exploration.



Abhyast

Boeing- IIT Kanpur Autonomous Vehicle Project

IIT Kanpur, in its Golden Jubilee year has embarked upon student projects, creating avenues and platforms for budding, innovative thoughts and ideas, thus tapping the immense potential of the student community. The Autonomous Vehicle project named 'Abhyast' (a Sanskrit word meaning 'getting accustomed to its environment') is one such initiative under the Dean, R& D sponsored by Boeing, the leading aerospace and defence corporation. The project is being coordinated by Dr. S. Bhattacharya, (Dept. of Mechanical Engineering, IIT Kanpur).

In 1998, Defence Advanced Research Projects Agency (DARPA) launched the Tactical Mobile Robotics (TMR) program with a long-term objective of dominating the urban battle space by employing a team of mobile robots in interior and exterior conditions. The program provided a strong impetus to the development of light unmanned ground vehicles and many autonomous and semi-autonomous vehicles were made under this program. In the next few years many such programs were launched leading to development of many vehicles in the category of small UGVs.

ABHYAST in the making

Designed primarily for navigation through an unstructured environment, the vehicle is in its early phase of engineering, would do simple path planning and obstacle avoidance, to reach its destined position, collecting pictures from environment and sending it to Operator Control Unit (OCU). In the later stages the vehicle will morph itself into a much sophisticated version, whereby it will simultaneously localize and map itself, stream live videos and optimize itself under different modes of function. Building a robot, however requires more expertise than simple programming.

Locomotion actuators manipulators, control system, sensor suites, efficient power supply well engineered software, all of these subsystems have to be designed to fit into an appropriate package suitable for carrying out the robots task.

Body Engineering

The main considerations in designing the vehicle were the choice of locomotion and drive system, space & weight optimization, terrain adaptability and obstacle scaling mechanism.

Since the vehicle would be manoeuvring through

unstructured landscape, tracked locomotion system was preferred to wheeled or legged systems, which were either too un-adaptive or too complex both mechanically and in controls. Tracks help in adapting to surface undulations and provide good stability with its large ground contact area although frictional losses lead to significant increase in power consumption. The drive is based on skid steering mechanism where steering is accomplished by actuating each track at a different rate or in a different direction, causing the tracks to slip, or skid, on the ground. Skid steering is the most convenient drive system although it poses challenges to the odometry (use of data from the movement of actuators to estimate change in position over time) and localization of the vehicle.

However, simple track geometry such as in a tank would offer us limited scaling possibilities in terms of height of the obstacle thus we had to come up with some other design to augment the obstacle scaling capabilities of the vehicle. The solution found was inspired by design of a similar robot "*PackBot*" developed by the iRobot Corporation. Flippers are a pair of auxiliary tracks which vary the footprints of the vehicle depending on the amount of traction needed. They change their orientation to facilitate the vehicle in adapting to surface undulations and scaling obstacles that are encountered while manoeuvring the terrain. A Passive Double track mechanism is employed wherein a single pair of motors actuates the main tracks and the flippers. Another motor is used to play with the orientation of the flippers.

The choice of material was also a crucial parameter. The chassis will be fabricated out of aluminium composite which will not only provide high strength but will also drastically reduce the weight of the vehicle. The drive system and the batteries are stacked close to the base to keep the centre of gravity as low as possible while the electronic components are all stacked over it to shield them away from vibrations and magnetic effects of the drive system. Robust and lightweight polypropylene rubber tracks shall be employed for better traction on the terrain. The vehicle would easily fit inside a cube of side 30cm and would weigh around 7-8 kg. The estimated speed of the vehicle during normal operation would be 0.5 m/s.

On Board Computer and Navigation (OBC)

The On Board Computer is the brain of our robot. Anything computational ranging from simple motor control to health monitoring is done by the **OBC**. We know that to give the robot a certain degree of autonomy, we need to carry out a lot of complicated tasks in a parallel fashion. Hence to meet our requirements, we

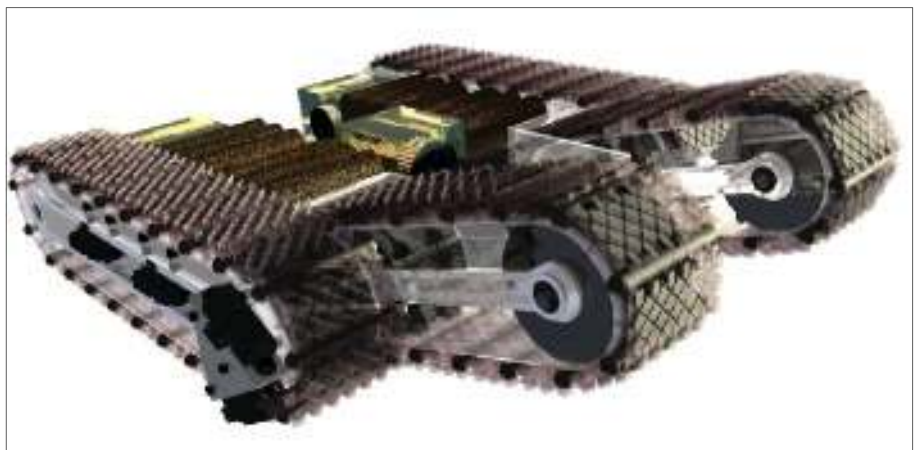
would be using a powerful processor. The OBC would perform a lot of parallel tasks, some of which are detailed below:

Navigation Control: - Navigation of the robot is one of the major processes that need to be monitored for attaining autonomy. It is the process of reading and controlling the motion of the vehicle. Navigational data primarily consists of acceleration (along three axes), angular acceleration and absolute position. In fact, navigation control basically culminates to estimation of robot's position or, simply stated, answering the question "Where am I"? Position can be estimated in the following two ways: -

Relative Positioning: This technique, as the name itself suggests, measures the position vector of the robot with respect to its initial position. This task is accomplished by integrating the motion parameters (acceleration along the 3 axes and angular rate derivative measured by the Inertial measurement unit (IMU)). The IMU is mounted at a strategic position on the robot. This is a better approach than using odometry (calculating motor rotations) since ours is a tracked vehicle which has the inherent disadvantage of slipping.

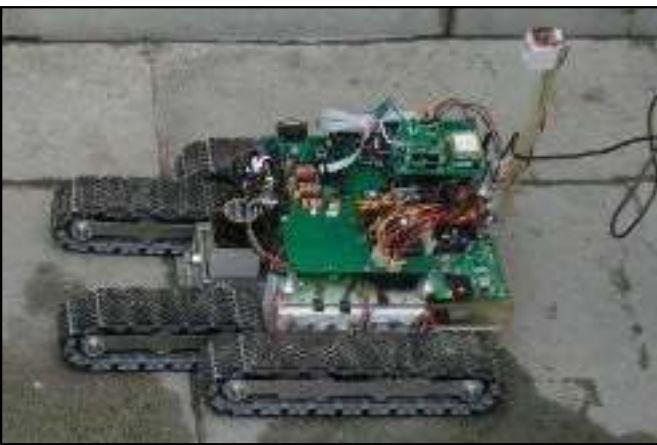
Absolute Positioning: It is the estimation of position of vehicle in a global frame of reference and is accomplished with the help of a Global Positioning System (GPS) coupled with an electronic compass for direction sensing. Now the question arises- What is the need of this when we already have a relative positioning system on our robot. We know that the readings of the IMU are erroneous and it accumulates with time. So we use the absolute positioning system as a corrective measure to keep the error fairly small.

Filtering of Data: : The measurements made by these devices are pretty noisy and if not properly dealt with, can accumulate an error of up to 10 meters between the estimated and real position. So we need a proper filtering mechanism for reducing the noise level in the acquired data. For this, we are using Kalman Filtering, which is described below:.



Kalman Filtering: Kalman filtering is a mathematical tool which filters the acquired data with the help of stochastic tools in a recursive manner. Kalman filter models the measurements as normally distributed due to the inherent noise. We need to estimate the initial data set (acceleration and position) and the error covariance matrix associated with the devices (IMU and GPS + compass). The filter then performs a series of statistical computations and as the process continues, the error from the real value finally reduces to highly acceptable levels. It has been observed that the reduction in error is up to 90%.

Path Planning: Path planning is basically an intelligent fusion of algorithms which helps the robot to decide a path to its destination based upon the surroundings (or obstacles, stated simply) as sensed by the robot itself. The inputs required for this are the obstacle positions which are acquired through the laser scanner, sonar and Infra red sensors. The laser scanner provides a 240 degree obstacle profile within 5 meters radius around the robot. Since it can only sense obstacles with height above



the horizontal plane on which it is mounted, so to avoid other obstacles (which we may even surmount using our flipper assists), we place the IR proximity sensors at strategic locations which may act as interrupts in our regular path planning indicating an immediate obstacle.



Various algorithms which may be put to use by us are path planning by fuzzy logic controllers, state based behavior Control, Dijkstra's algorithm, temporal differencing, and even Neural Networks!!

Batteries: Li ion battery packs will be used as they have high power and energy densities. The bulk of the power will be consumed for the locomotion of the vehicle. The batteries can power the vehicle for approximately 1 hr.

Health Data Monitoring: Last but not the least is the health monitoring of the robot, which includes scheduled dispatch of health data like **Tilt, Pitch, Speed, Battery status etc.** to a monitoring or control unit and taking the necessary action in case of emergency-like if the robot has run out of power or is stuck somewhere. We plan to send the data through GSM network.

Conclusion

Using all the above adaptive control processes our UGV should be able to traverse a given route autonomously negotiating difficult obstacles while protecting itself from collisions and falls. The phase I of the project would be completed by February 2010. The Phase II of the project has also been initiated and a new group of 16 students have been selected by the advisory committee, who would focus on the System Optimisation, Health monitoring, and developing gas sensors for detection and monitoring in chemically hostile environment. They would also be working on swarm intelligence in which the master robot Abhyast will coordinate with a number of slave robots to accomplish specific tasks. Get prepared to find ABHYAST roaming around in our campus without human intervention!

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2010- International Year of Biodiversity

The United Nations has declared 2010 to be the International Year of Biodiversity (IYB) - a celebration of life on earth and of the value of biodiversity for our lives. The main objectives behind IYB are to raise awareness of the importance of conserving biodiversity for human well-being and promote understanding of the economic value of biodiversity, enhance public knowledge of the threats to biodiversity and means to conserve it, and encourage organizations (and through them individuals) to take direct or indirect biodiversity conservation activities. For more details, please visit <http://www.cbd.int/2010/welcome/> and <http://www.countdown2010.net/year-biodiversity>.

The continuous bombardment of the Moon by comets and meteoroids has most likely added small amounts of water to the lunar surface. On September 24, 2009, the Indian Space Research Organisation (ISRO) reported that their first lunar mission, Chandrayaan 1 using NASA's Moon Mineralogy Mapper, found evidence of large quantities of water on the Moon's surface, and that water is still presently being formed. On November 13, 2009, NASA announced the results of the Lunar Crater Observation and Sensing Satellite, saying that "not just water, but lots of water" had been found by the mission near the southern pole.

PRESS CONFERENCE NASA , ISRO FIND WATER ON MOON



"Ladies and Gentlemen of the press, I have a confession to make. What the Space Organizations found was not really water. I was extremely nervous after putting the first footstep on the moon so I had to relieve.."

Puneet Singh, NERD Team member

Do you want to make a beginning in astronomy? The very first thing to do is observe. Observe the sky that you see every day, every night more keenly and try to deduce patterns in the stars and their motion. Do you see some patterns of stars that remain constant over time, i.e. do you see the same pattern every night? These patterns are called as constellations.

Now coming to the motions of the stars, since the same patterns are found to repeat themselves, we make a crude assumption that all the stars are fixed on a sphere of infinite radius concentric to the earth, called the 'celestial sphere', and that the celestial sphere rotates about the fixed earth from east to west every sidereal day. A sidereal day is approximately 23hrs and 56min and is the time taken by the earth to rotate once about its axis. 24 hours is the average time between two noon's, essentially its the average length of a day. Why is there a difference between the two will be explained in Fig 1.

We see that the earth has to rotate a little more than 360 degrees to face the sun every day, this time between noons is 24 hours and is called the 'solar day', hence the time for a complete rotation of the earth is actually lesser than 24 hours, it comes out to be 23 hours and 56 minutes approximately. This 4 minute difference per day becomes a whole day over the year. Now suppose the earth didn't rotate every 23hrs 56mins and it only revolved around the sun, then with respect to the sun,

Twinkle Twinkle Little Star

Astronomy 101
(Getting started)



Karthik Vijayakumar

the earth would have completed one rotation in one year, this one rotation is essentially what that one day difference is, over the year.

Now let us get back to constellations. We understand that there are consistent patterns in the sky and hence in the celestial sphere. Now consider the plane of rotation of the earth and extend it to infinity, it would intersect the celestial sphere in a circle, this line is called the ecliptic. The ecliptic represents the path of the sun in the celestial sphere over the year, i.e. if we note the position of

the sun on the celestial sphere every noon from a fixed place, the curve that we would trace on the celestial sphere would be the ecliptic. Now the ecliptic passes through certain constellations in the celestial sphere, these constellations are called the zodiac. There are exactly twelve of them, which is why there are only 12 zodiac constellations. The sun stays in each constellation for the same period of time, which is why there are 12 months a year.

Now that we know what are zodiac constellations, let us try to answer a fundamental question, why is Aries the first zodiac constellation. To answer this we first have to understand what are equinoxes and solstices. As we all know the earth's axis of rotation is not exactly perpendicular to its plane of revolution, this is what causes the seasons on the earth. Now extend the plane of the equator of the earth to the celestial sphere, the circle in which it intersects the sphere is called the celestial equator.

A natural question would be, wouldn't the celestial move over the year since the earth revolves around the sun?

One should realize the earth's equatorial plane moves parallel as the earth revolves around the sun, and since the celestial sphere is of infinite radius, all the equatorial planes would intersect in the same circle, hence there is a unique celestial equator. The celestial sphere rotates on an axis perpendicular to the celestial equator, hence all the points on the sky would move parallel to the celestial equator.

Try to visualize at every point on the earth the celestial equator, it would be a line from the east to the west. Now the sun too must move parallel to the celestial equator every day, but only when the sun lies on the celestial equator, will it perfectly rise in the east and set in the west giving us equal day and night, but this happens exactly twice a year, at the points of intersection of the ecliptic and the celestial equator, these two are the vernal equinox and the autumnal equinox.

These are the two points on the earth's orbit when the length of the day and night are equal. So now, we are able to visualize the two motions of the sun on the celestial sphere, one the everyday movement parallel to the celestial

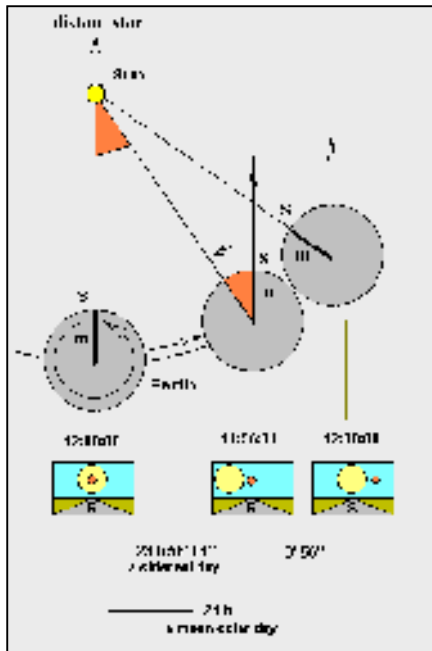


Fig 1
Source: <http://hansgunawan-astronomy.blogspot.com/2009/03/waktu-sideris-dan-waktu-sinodis.html>

equator, due to the earth's rotation, the other the annual motion of the sun along the ecliptic due to the revolution of the earth around the sun. Similar to the equinoxes there are two points on the ecliptic which are farthest from the celestial equator, these are the two solstices, the winter solstice and the summer solstice, which correspond to the shortest and the longest day respectively. (Fig. 2)

Now that we understand equinoxes and solstices, let us get to our old question, why is Aries the first zodiac constellation.

One can understand that equinoxes and solstices occur at exactly the same points on the earth's orbit every year, hence they correspond to fixed points in space, in the frame of reference of the sun and the solar system. Hence they can serve as point of reference, during Greek times the transition from winter to summer was considered auspicious, hence the vernal equinox was chosen as the

reference, one can observe that the vernal equinox lies in the zodiac constellation Aries, hence Aries was chosen as the first zodiac constellation, and the remaining follow in the order of the motion of the sun over the year.

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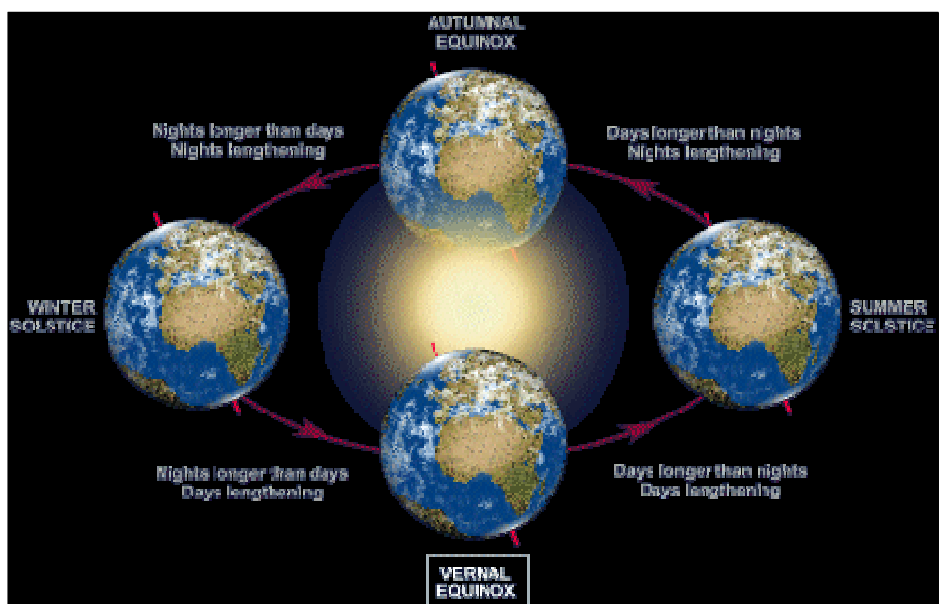


Fig 2
Source: http://www.glyphweb.com/esky/_images/diagrams/vernalequinox.gif



Secrets of Good Teaching

Interview with Dr. Lilavati Krishnan

(Head, Dept. of Humanities and Social Sciences, IIT K)

Mohit Kumar Jolly and Puneet Singh

Dr. Lilavati Krishnan needs no introduction. She joined the Department of Humanities and Social Sciences at IIT Kanpur in 1978 and has been with the institute since then. She is known for encouraging critical thinking in her courses, and is the apple of many eyes of students who have ever attended her PSY 151 (Introduction to Psychology) class. NERD team members get the privilege to have an exclusive interview with her regarding her experience, pedagogy and other social aspects. Here are some excerpts:

NERD: You have been a faculty member in IIT Kanpur for more than three decades now. What is the most distinguishing feature you feel about the institute?

Dr. Krishnan: Freedom -freedom from every point of view, freedom to choose what you want to teach, how to teach- this is the most outstanding feature of the institute. In addition, the intellectual level of the students as well as the faculty is inspiring and academically stimulating. The environment is clean and peaceful, and there are no compelling norms. I am free to live life the way I want to.

NERD: A professor of Humanities and Social Sciences (HSS) in an engineering institute for the past 30 years - what made you choose such a unique post?

Dr. Krishnan: When I joined the institute, I was aware that I am getting into an engineering institute, and it is going to be strange for me, but I knew it would be special, because I had a unique role to play. IIT Kanpur was one institute where HSS courses are an important part of curriculum, and this was a big reason for me to come here.

I experienced great exhilaration in my first week itself. Incidentally, when I joined, one of the faculty taking a psychology course had to go somewhere and she asked me to take her class. So, to get an idea of what was going on in the lectures and how it was taught, I sat in her class, and I got the taste of how the students were as an audience. One lecture was enough. Such a beautiful experience ! Lots of questions were asked and the students responded very actively to the teaching. I realized that I have a challenge, but it was nothing to be afraid of, and the best part was that I knew the next day there would be more of this. Students were so willing to learn that it always made me excited and more prepared. It was quite different from my first teaching experience (before joining IIT Kanpur). In past 31 years and 25 days

I have been here, not a single day did I have any regret. I may be an odd creature out in this technical institute, but I am privileged to be here and it has certainly paid its rewards.

NERD: We have heard some professors even vouching for closing the HSS department at IITK. What, in your opinion, is the significance of HSS courses in an undergraduate engineering degree?

Dr. Krishnan: Everyone is entitled to his/her opinion. My own view is the following. Prof. Kelkar was a great visionary, who made HSS courses a part of the IIT curriculum here. Let us ask the question - Why is HSS needed ? If we are making engineers here, aren't they human beings first ? They might deal with machines but ultimately they have to deal with human beings. HSS courses also teach B Tech students to think in a different way and in a different direction. I think that should be the philosophy.

Then comes the criticism that HSS courses teach only theories rather than practice. This may be partly true, but there is an attempt to bring out the practical aspect along with the principles. HSS courses in Psychology, Sociology, Economics and Philosophy talk of theories on the working of society. English is about appreciating and enjoying what people write.

It is sad that even among our own faculty, some feel there is no place for HSS, but many alumni of the institute have mentioned that HSS is one of the distinguishing features of their academic curriculum here, and it is something they have used the most.

NERD: Students love and respect you for the way you have been teaching PSY 151 and many other courses. What pedagogical techniques adopted by you always made you so different?

“Freedom to what you want to teach, how to teach- this is the most distinguishing feature of the institute.”

Dr. Krishnan: That is a difficult question, and my honest answer is that I cannot specify any formal pedagogical technique as such. I have been self-analytical in the way I teach. I believe that teaching is learned, not from books, but from students. It is not a formal technique that necessarily makes a good teacher. The philosophy is to have the commitment. As a student I was fortunate to have excellent teachers myself - not in terms of being known, but in terms of having a presence in class, and having an influence. And I have always had the right kind of students as well.

NERD: You have also authored 'Teacher lessons' in Dr. Viney Kirpal's 'Secrets of Good teaching'. What pedagogical changes would you suggest at IIT Kanpur?

Dr. Krishnan: I can't teach anyone how to teach. Let the teacher teach the way he/she wants to. Thank God that this freedom exists at IIT Kanpur!

Some teachers can be extremely creative. We have faculty who show small cleverly designed experiments even outside the class, or have unusual ways of presenting visual aids. Let the teacher himself/ herself find out what makes the students responsive in his/ her class.

Regarding student attendance, I feel that ensuring attendance in class is not really a part of pedagogy. Whether or not one teaches well cannot be gauged merely by high or low student attendance. The two things are only loosely related. At another level, even teachers have a bad semester from time to time. From the point of view of the teacher, when you have low attendance, the feedback in the class is missing. The joy goes out of teaching.

Regarding the content of courses, there has been an emphasis on reducing the content of courses on the ground that too much content may create stress. I believe that cutting down the content too much, or making courses too easy may not be good. You must put in some challenge for the students. There is something called positive stress (eustress), and students must be trained to cope with this kind of stress. This would be one way to bring out excellence. Take the case of athletes. They keep raising the bar until they reach a level that they cannot manage. In other words, you must 'push' a person to make him realize his potential, and hence some optimal level of stress is unavoidable. Otherwise this will no longer be an institute of excellence. In this regard, we have to listen to student feedback of course, but with proper adjustments.

NERD: Please tell us about some of your interesting

“Teaching is learnt not from books, but from students.”

experiences in class.

Dr. Krishnan: I try to consider every class an interesting experience for me. Sometimes students make remarks or questions that are really eyeopeners. I will give one example that stands out in memory. Once, as part of the lecture, I asked my class what would be an 'unusual event'. Someone said "A fan falling on my head". Then someone said loudly : "You coming to class 5 minutes late !" That really struck me. It put more pressure on me never to be late for my class.. This comment made me realize that students notice even small aspects of a teacher's behaviour, such as punctuality.

NERD: You are known among students for encouraging critical thinking in your courses. From your experience, what can you say about whether the present rat race behind JEE brought a decline in students' critical thinking and learning attitude?

Dr. Krishnan: The attitude has changed to 'test taking' rather than 'critical thinking'. But the potential and ability for critical thinking are very much there. The impression that good marks is all that matters has strengthened. Unfortunately, studies in school rely on non-critical thinking because that is far more easy for students, and also for teachers.

It is largely up to the teachers to make students think creatively and critically. When I have to make a question paper for universities, the task is easy, and I can't even think of including a critical thinking question. Here, on the other hand, I take 3 days to make questions for a quiz.

NERD: We have been hearing about the decline of students' interest in academics. Attendance has witnessed an exponential decrease by students in last one decade. What, from the point of view of a teacher do you think are the major reasons for the same?

Dr. Krishnan: Low attendance is a multiply caused phenomenon. One of the reasons could of course be dull teaching and boring classes, but I don't think this is the most important one. Another reason, I feel, is photocopied notes. Why is it necessary for a student to come to class if he knows he can photocopy his friend's notes ? This factor has come with time. In a way, technology has played a huge role in diminishing attendance. Photocopy machines only came here during the mid 80s - before that, decreasing attendance was not a big problem, as far as I can remember.

Then class notes also started to be available on internet. In my class, a student asked me to put up my slides on the web. I asked him, "You want another reason not to

come to my class?" Some professors feel that they can put up notes on e- bulletin boards and evaluate students based on group discussions on those topics, a model that is followed overseas. In my opinion, this mode still takes away the face-to-face interaction between teachers and students. What is a classroom then ?

Some faculty members do not seem to face a problem with student attendance. Some give weightage for attendance. I also give a small percentage of marks for 'class participation' in some of my courses. Such measures may still not ensure attendance. A new feature that may account for low attendance is the increase in numbers. The students feel that in a large class, his/her absence will not be noticed. It is indeed impossible to see who is present or absent in large classes of 80-90 students, but this is an extremely recent phenomenon.

NERD: Among all IITs, IIT Kanpur is the only institute where there is no mandatory attendance policy as of now, and the current ARC is thinking of the same. Do you think that the time has come to change the 'Spare the rod and spoil the child' policy of IIT Kanpur?

Dr. Krishnan: Ideally, there should be no need for a penalty for absence, or a reward for attendance. But I am in favor of a mandatory attendance policy, as it has become necessary, unfortunately. Ultimately I hope that students would themselves realize the importance of coming to class, and there would be no need to enforce anything.

NERD: What changes have you observed in the student-faculty interaction as a social psychologist?

Dr. Krishnan: The interaction has changed drastically- not just the frequency but also the nature. The causes are difficult to state. People have tried to give explanations such as students not having enough free time, and going through stress, especially since the time when the 5 year B.Tech curriculum was compressed into 4 years. Not only faculty-student, but also student-student interaction went down. I don't agree that this (change from 5-year to 4-year programme) was the only or the main reason. In fact, I feel that if stress goes up, then the interaction should also go up, because the need to talk about your problems also increases. There must be other explanations for the change in faculty-student interaction.

I think this problem is not confined to the boundaries of IIT Kanpur alone. Times have changed. People have become self-centered, and it is because they can afford to. For example, before television came, the only source of entertainment was talking with your neighbors, and

friends, but once that box was in your home, one had no need to go out talk with people. The overall interaction has gone down in cities and this may be a feature of society at large.

NERD: You conducted the Annual conference of National Academy of Psychology at IIT Kanpur in December 2007 themed 'Psychology, Technology and Society'. Could you tell us more about the conference?

Dr. Krishnan: I must admit that in the beginning I was not very comfortable with this theme, but it was while writing the proposal for funding from various agencies that I discovered connections between these intermingled aspects. During the conference, we had very good sessions that brought out the connection between these three components. Dr. Dhande gave an excellent talk on technology and society, and we also had other presentations relating technology and psychology. Some of these were in the area of health psychology, which brought in the impact of technology and psychology on society.

NERD: You have held responsible positions in academic administration – Chairman of Curriculum Development Monitoring Committee (CDMC), member in previous UGRC, member of Senate Educational Policy (SEPC) etc. Kindly share some of your administrative experience.

Dr. Krishnan: In CDMC, I became involved deeply. I learned a lot, especially when I had to make reports on all things being done or discussed in various committees. All core courses were evaluated very comprehensively and with meticulous attention to the details. Considering all the developments in the field, the courses are continually updated. Even today, constant reviewing of the curriculum is going on. The core course component is handled by CCC (Core Curriculum Committee). All must continue. The flexibility within the limits set by the system at IIT Kanpur must be maintained.

NERD: Tell us something about CCWP (Center for Creative Writing and Production) and its activities.

Dr. Krishnan: At present, Head HSS is the ex-officio Chairman of CCWP. In its early days, CCWP was an independent unit, and was headed by a well-known Hindi writer Mr. Giriraj Kishore (who had also been Registrar at IIT Kanpur). He conducted several literary and other events. After his retirement, the Head, HSS was made the Chairperson of CCWP. Many creative endeavors can be encouraged by this unit, and I would particularly like to encourage student activities in this area. I am saddened to hear that Alfaaz, the literary festival of the Students Gymkhana has been discontinued. It was a beautiful event. Maybe CCWP can help the students to revive this activity. Other activities are also possible.

“I am in favor of mandatory attendance policy, as it has become necessary, unfortunately.”

“I would particularly like to encourage student activities in areas like CCWP.”

NERD: We have also heard that you have deep interest in music. Kindly elaborate on the same.

Dr. Krishnan: Music is a part of my life. While at IIT Kanpur, I learned vocal Classical Hindustani Music formally from 1980 to 1996. I still continue my own practice although not as regularly as I would like it to be.

NERD: What are your plans after retiring as a faculty?

Dr. Krishnan: Besides reading and writing, I would like to participate in community work. So far I have not been able to contribute as much as I want to in this area. My primary responsibility and role as an academician has not allowed me time to do so – I would like to do that kind of work after retirement if possible.

NERD: What is your final message for the students?

Dr. Krishnan: Be the best you can be as a person. Get the maximum out of yourself. Work not to win awards, but to get a sense of satisfaction. Awards may bring you credit and recognition, but they may not necessarily give you long-term happiness.

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Puneet Singh (punsingh@iitk.ac.in) is a second year undergraduate at IIT Kanpur. He is interested in Helicopters, Rotor crafts and Rockets. He also makes Cartoons in his spare time and reads books.



Egg yo

The future of kitchen and dining solutions

Arun M

The Egg yo is a smart solution whose primary goal is to meet the needs for preservation, preparation and storage of food, by using existing technology and design a feasible, affordable and versatile solution. This project is being done in collaboration with the Helsinki University of Technology, Rhode Island School of Design and MIT. This entry won the first prize in DESIGN CONCLAVE organized by FICCI (Federation of Indian Chambers of Commerce and Industry) in 2008 in the category Product Design for Global market.

With the increase in population density of urban working youth in all the metros, space has become an important issue of concern, and hence management of spaces through design of compact, multifunctional, space saving solution is playing a vital role in bringing balance to this demand and supply disharmony.

The product 'Egg yo' is targeted to the user belonging to the urban working youth having a technology driven lifestyle. They are environment conscious, trend conscious, brand conscious and have a fast lifestyle. The product design process can be explained as follows—primary Requirements are food preservation, food preparation, cleaning and food disposal. (Specifications and Constraints as formulated for the project are as given in table below.)

Qualitative	Quantitative
Compact	1000mm<length<1500mm
Mobile	1000mm<breadth<1500mm
Time saving	2150mm<height<1650mm
Energy efficient	Climatic class: 18-43° C
Easy maintenance	Life Durability: 7 to 10 years

Table 1

The backbone of the concept lies on the fact that egg is one of the simplest examples of protection and nourishment from nature. The basic form and function of the design is inspired from an egg. Hence the name Egg yo. Egg yo will serve all the major functions of a kitchen on a smaller scale.

There are three different kinds of storage zones:

- Non Cold Storage: The two small stools as shown above act as sitting provisions for the user as well as for storing items like rice, potatoes, onions etc. which does not need cold storage.

- Freezer: At the bottommost part there is a normal freezer which caters to the normal refrigerator function.

Having the circular storage spaces revolving around the central axis user can browse through all the items in the fridge by simply rotating the disc. If some big bottles, packets etc. need to be

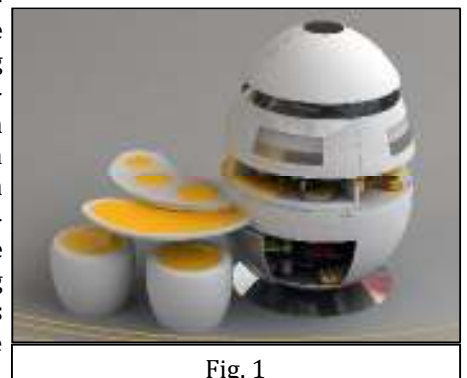


Fig. 1

stored the circular shelf can be adjusted as shown to fit the user's requirement.

- Cold Storage: The topmost part provides a chiller/cold storage space. This space is divided into two parts and can be operated separately. This gives the provision for storage of items like fish, meat etc on one half and ice creams, butter, beverages etc on the other. The doors operate by a vertical lift swing mechanism.

- The middle two edges can be rotated to get an electric stove for cooking food as well as a table for having food (Fig 2). Three electric burners aligned according to their hierarchy of size along with a touch sensitive control unit provides perfect mapping for the user to cook food at the desired burner. These are part of the system which can be pulled out when required thus providing customizability of the solution according to the user's need.

The control unit for the burners in the electric stove displays intensity of colour according to the temperature of the burners and thus the user can get an idea of how hot a particular burner is from the colour information around the switch as shown.

The middle portion has 4 different sections: The microwave, the wash basin & Bin, the crockery storage section and the mixing grinding section.

The Microwave has functions of Grill and Convection with controls from an embedded smart touch control panel. The Vertical swing lift operated lid when closed hides the control panel and thus brings aesthetic harmony to the remaining 4 sections at the middle of the egg yo. Existing technology with change in fabrication can be used to fit the microwave at its designated place.

This section provides water for washing as well as drinking. The tap being operated by a smart control panel

The Microwave has functions of Grill and Convection with controls from an embedded smart touch control panel (Fig 3). The Vertical swing lift operated lid when



Fig 2

closed hides the control panel and thus brings aesthetic harmony to the remaining 4 sections at the middle of the egg yo. Existing technology with change in fabrication can be used to fit the microwave at its designated place.

This section provides water for washing as well as drinking. The tap being operated by a smart control panel enabling the user to have hot or cold water a desired flow by just moving a dot in the graph of the user interface (Fig 4).

Technically the central supporting rod which holds all the different modules at different levels has an inlet and outlet in addition to the duct for electrical wire management.

There is a dust bin fixed with an activated charcoal tray for preventing stinking of disposed materials. This can be taken out and fixed with convenience and ease. The crockery storage space provides storage space for a limited number of essential utensils and crockery items for everyday use in a small family. Several assisting accessories can be obtained according to user's choice for efficient storage of crockery items.

The mixing grinding zone helps in cutting, chopping, squashing of different food items during the preparation of food. It has a standard mixer grinder with some assisting accessories like smart vegetable cutters etc.

In a whole, the Egg yo provides all the essential functions that can be required by a busy urban youth in preparing, preserving and having his food in a space constrained environment with ease and convenience.

Arun M (arunn@iitk.ac.in) pursued his Masters in Design in Design Programme, IIT Kanpur. My interest areas are user centered designing in the branches of Industrial Design and animation. I

am currently doing my Thesis on a project forwarded by NOKIA, Finland to develop a Mobile school Communicator for the upliftment of educational scenario in underprivileged section of third world countries.

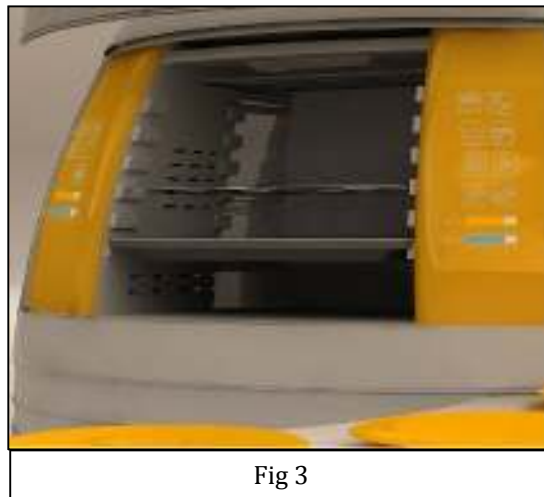


Fig 3

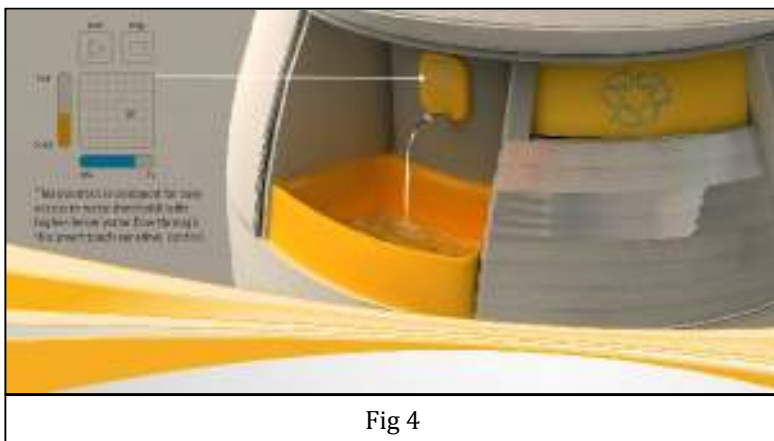


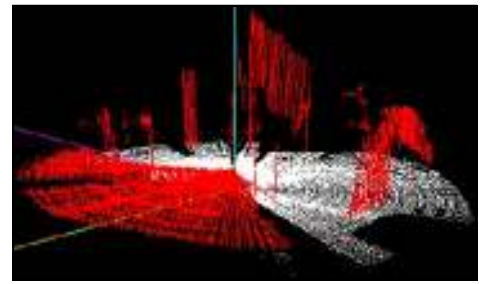
Fig 4



Lunar Rover

- Explore The Moon

Ashish Bajpai, Rahul Singh, Diwakar Agarwal and Kartikey Asthana



As part of Chandrayaan -2 ISRO plans to send a lunar rover to the moon for exploration and conducting scientific experiments. IIT Kanpur is participating in the development of two subsystems of the rover related to 3D map generation, navigation and kinematic control. Students are actively participating in developing a prototype rover for testing the algorithms developed for navigation and control. At present two groups consisting of UG, M.Tech and Phd students are working on the two subsystems as detailed in the following article.

Visual Navigation Group

Introduction:

The objective of our team is to develop vision based obstacle detection, path planning algorithms, analysis of the results and do simulation and experimental studies (to be done at VSSC) with respect to algorithms developed for the motion of the rover on lunar surface. Currently we are working on 3-D map generation of a given surrounding area.

Methodology:

We are using laser based terrain reconstruction technique for local map generation. The basic principle of laser based construction is that, when a line laser is projected on a terrain, due to unevenness and obstacles present on the surface, the image of laser line (when taken from a fixed point) is not a straight line.

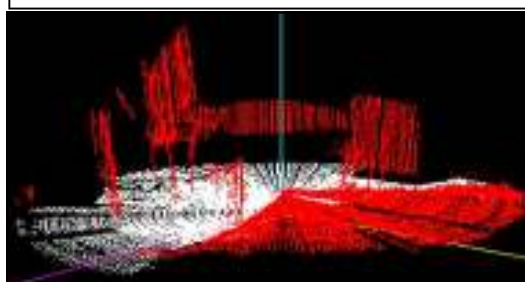
In Fig.1 it can be seen that when the laser line falls on a plane terrain then the profile is a straight line, whereas in Fig.2 when an obstacle is kept, the laser profile changes and a shift is seen. This is the same principle that is applied in laser based terrain reconstruction. The terrain data is represented in terms of 3D coordinates. The X and Y coordinates give us the location of the points on the horizontal plain surface that touches the wheels of the rover. The Z coordinates gives us the height information. So, terrain



Fig.1: Image of a laser line on a plane surface.



Fig.2: Image of a laser line on an uneven surface



Viewing map from point (1.5,0.5,1.0)

can be seen as a height function which depends on the location (X, Y). Height at each point (X, Y), $f(X, Y) = Z$

But the terrain is registered as a set of points each having (X, Y, Z) coordinates. Z (height information) is obtained from the shift that is seen in the laser profile. The (X, Y) coordinates are obtained from the straight line profile. The camera has to be calibrated with two planes. One is laser plane and other is the horizontal plane surface touching the bottom of the tires. Right now the task of the robot is limited to carrying out the local terrain reconstruction. That is, with the robot position fixed, it is made to model the local terrain i.e., a circular region of 1 meter radius centered on the robot. This is illustrated in Figure 3.

Robot for testing purposes:

Refer to Fig.4.

Sample height map generated:

In map, centre position corresponds to rover. Map is divided in 3 colored portion:

- White color region corresponds to reference plane on which robot is standing assuming it to be flat.
- Red color region is the region where laser lines detects some obstacles.
- Black color region stands either for the points those are outside scan area or for the points where laser line is not able to reach.
- Yellow line is X-axis, Light Green line is Y-axis, Pink line is Z-axis.

Motor Control And Interfacing:

The rover will move on very rough terrain that has obstacles, dust layer, craters, etc. Hence as a first step a one wheel test set up was designed and fabricated to study the interaction between one wheel and the soft sand like terrain (Fig.5). The task of this group has been dividing into the following (a) Interface the driving and steering motors of the one wheel assembly with the controlling computer system and to collect test data regarding slip, traction force etc., (b) measure slip using vision and motors current, (c) design of rocker-bogey mechanisms and design of a prototype rover.

The wheel of the test set up, has 2 DOF and is driven using two servo motors. We are interested in finding the conditions under which the wheels slips when subjected to a load. For this the wheel is driven with a constant velocity and the body on which the wheel is mounted is subjected to a drag force by moving it in the opposite direction. This helps in simulating motion on an inclined surface, sinkage, slip etc. Slip is measured by measuring the motor current and also by using a vision camera. Presently as the test is progressing, simultaneously a 6-wheel rover is being designed.

The main task of the students is in interfacing the motors with the controllers. The motor terminals receive inputs from the servo-amplifier ADS 50/5 which was used to amplify logic voltage generated through the connector block of the PCI6251 DAQ board. Pulse Width Modulation (PWM) was used to change the time averaged logic voltage being fed to the ADS 50/5, which in turn changed the shaft speed. Initially, the encoder inputs of ADS 50/5 were used to read the encoder signals and the 'Monitor n' pin was used to calculate the shaft velocity. However, finally, the encoder signals were de-

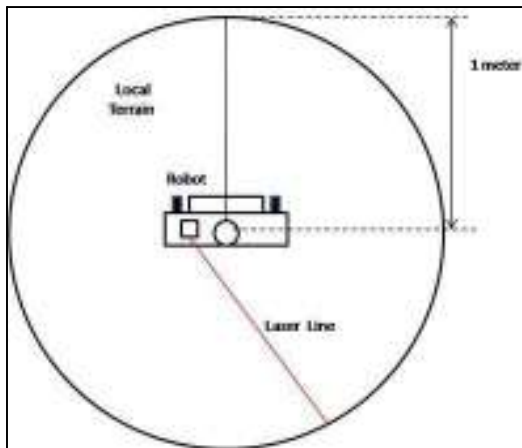


Fig.3: Local Terrain Reconstruction



Fig.4: Robot for testing purposes



Fig.5: One Wheel Test Setup

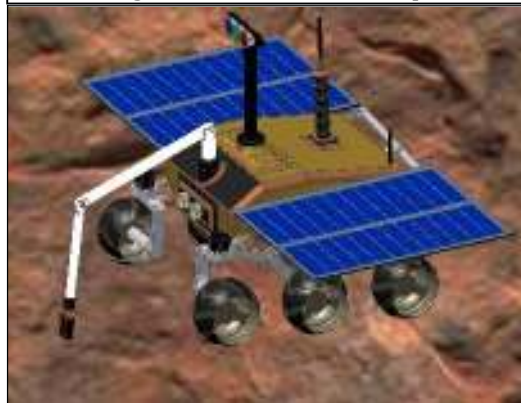


Fig.6: Proposed Rover

rived directly onto a circuit board and the number of rising edges were counted; the gear ratio was then utilized to obtain a measure of the angular velocity. The magnitude and direction both were obtained by using Channel A and Channel B of the encoder. A code is being developed for varying the logic voltages in a manner so that the change in shaft load does not change the shaft angular velocity beyond a certain min error range. Thus the code must work against any changes in the shaft speed.

A schematic figure of the proposed rover being designed in collaboration with ISRO is given in Fig.6.

Team involved in this project is:

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Kirigami—the art of paper cutting

Role of paper toys in eradicating insect phobia in a community

Insect phobia is widely prevalent in society, and has far reaching consequences. Our knowledge is limited to insects being pests. When a species gets extinct in the insect family, it disturbs the biodiversity of planet but does not evoke sympathy in our community. This article talks about using Kirigami (art of paper folding) to eradicate this phobia, and gives a message that by distributing insect toys made of paper among school children and imparting them the skills to make insects out of waste paper, their awareness about insects should be enhanced. They can take home what they learn in school, and hence the entire families get educated in a period of time about insects (and their role).

Dr. V.S.S. Sastry

Introduction

Insect phobia is cultivated in very young age among children, the reason being, that they may get hurt by insect bites. The natural curiosity of children to touch and explore is curtailed in the insect domain, as they are prevented from holding insects in their hands. This phobia then gets carried through the adolescent stage.

Most insects are seen only as pests and harmful creatures. To the extent, they are looked upon as Evil invading earth, out of Pandora's Box. At the most, communities' appreciation gets limited to appreciating butterflies, and hence it is quite difficult to educate communities to understand and appreciate biodiversity issues and beneficial nature of insects.

Many efforts have been made in this direction, but to increase awareness among children, they can be imparted knowledge to make varieties of insects. Only then they will come to know the morphological aspects and beauty in insects in colour. We used Kirigami (art of paper cutting) for helping children explore this fun.

Methodology

A) There are ample numbers of colorful advertisements in newspapers and magazines. Once a newspaper or magazine is read, it is considered old and waste. People discard old magazines which are printed on glossy and fine quality paper, and their only use is to make covers or recycle them as paper pulp. This material is used to prepare and make insects.

B) Any insect's body is symmetrical (morphological symmetry). Asymmetric insects do not exist. This yields to make their contours easy, by folding paper longitudinally.



C) A sharp scissor can cut the contours of the insect

shape written on it. When you separate the extra paper you get this.



D) Using tweezers the legs be bent at ankles and wings lifted up then the cut paper looks like this.



E) This insect cut in paper is put in a transparent box, its legs stuck to bottom of the box. Underneath the insect a white paper is used.

F) Then the Insect looks exactly real which evokes great admiration by any one looking at it.

Advantages: In the number of hours spent in copying insect drawing, choosing right colors in advertisements in magazines or newspapers and encasing them in a box of suitable size, one acquires sufficient skill and knowledge to match the colors in a magazine paper with insect colors known.



Conclusion

- No extra cost required to make insects.
- Waste paper or magazine paper is recycled.
- No extra coloring required. (At the most two dots made by pen for the eyes).
- Children can handle them easily.
- Insect phobia vanishes among children, and over a period of time, entire community gets educated.
- The skill does not require extra instruments other than scissors, tweezers and pin.

The pictures of insects are widely available in Encyclopedias, and Entomology books. Children were encouraged to make collection of different Paper insects. Children took these skills home and made insects. They began to play with them and adults too enjoyed playing.

Dr. VSS Sastry (vsassastry@gmail.com) is affiliated to University of Hyderabad. He has also written some books on Origami and Kirigami, one of them being *Origami—Fun and Mathematics*.



1.61803398.... The mysterious Divine Proportion

Aayush Gupta



Have you ever thought what makes Angelina Jolie different from you? What actually makes her beautiful?? Well the answer is (unbelievably!!) mathematics.

We will get to this later. First of all let me tell you about a special number, rather a special ratio, called The Golden Ratio. To define it in simple words, any two numbers are in the **golden ratio** if the ratio of the sum of the numbers to the bigger one equals the ratio of the larger one to the smaller one. The golden ratio is an irrational mathematical term, approximately 1.6180339887.

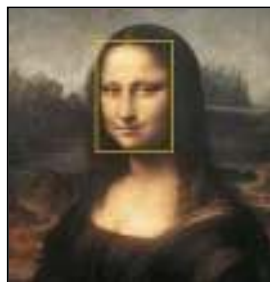
$$\frac{a+b}{a} = \frac{a}{b} = \varphi.$$

This equation has a unique solution which is

$$\varphi = \frac{1 + \sqrt{5}}{2} \approx 1.6180339887 \dots$$

I know history has always been a boring thing to study, but the history of this ratio is very interesting to know.

Historically this number was first studied by Greeks due to its frequent usage in their geometrical usage. Its discovery is mainly attributed to the great mathematician, Pythagoras and his followers.



ens, including the Parthenon, concluded that many of its proportions were approximately equal to the golden ratio. The Parthenon's facade (Fig.1) as well as elements of

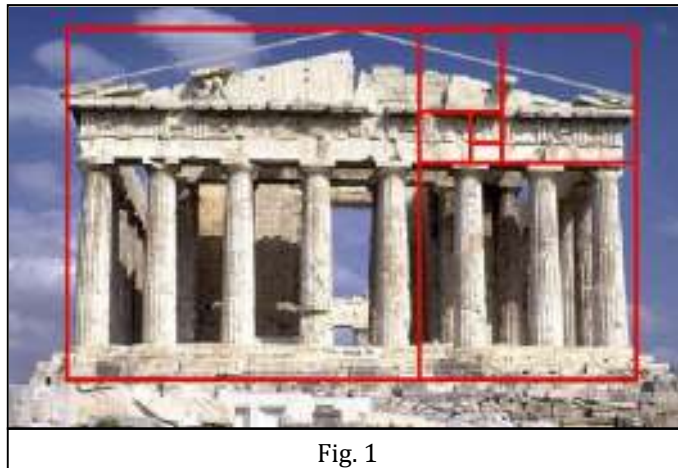


Fig. 1

the facade can be circumscribed by golden rectangles. You will also be surprised to find out that that ratio of consecutive terms in Fibonacci series tends to this golden number when we move higher up in the series.

Leonardo da Vinci's illustrations of *De Divina Proportione* (*On the Divine Proportion*) and his views that many bodily proportions exhibit the golden ratio have led some

scholars to anticipate that he incorporated golden ratio in his paintings. Some even say that his *Mona Lisa*, employs the golden ratio in its geometry.

In 1859, the pyramidologist John Taylor claimed that, in the Great Pyramid of Giza (Egypt), the golden ratio is shown by the ratio of the length of any face (the slope height), inclined at an angle with the ground, to half of the length of the side of the square base. The above two lengths were approximately 186.4 and 115.2 meters respectively. The ratio of these lengths corresponds to the golden ratio, accurate to more digits than either of the original measurements.

Another form of arts, music, has also been touched by this miraculous ratio.

Some studies of the Acropolis (a Greek sculpture) in Ath-

(continued on page 35)

Playing with Plasma

Wave interaction with bounded plasma confined in a Magnetostatic well

Indranuj Dey

In recent times, plasma science and technology has entered our daily lives in various forms. Its presence is both overt and covert in many of the applications and appliances that are in daily use. The earliest example of applied plasma is the fluorescent tube light, and a recent application being the plasma television. What most of us do not know is that, the widest application of plasma today is in the field of micro and nano fabrication. Indranuj Dey writes more on the subject:

Introduction:

In micro and nano fabrication, plasma science and technology can be seen in plasma etching, plasma deposition, and ion implantation, which are used in the process of fabricating ICs and microprocessors. Plasma also finds application in the research in fields of bio and material sciences, and is the protagonist in the development of a self-sustaining fusion reactor, the Holy Grail of energy research.

The Waves and Beams Laboratory, Department of Physics - IIT Kanpur, carries out research primarily in the field of micro-

wave generated plasmas, and its applications to development of multi-elemental focused ion beams (ME-FIB) for nano-science studies, and negative ion beams for bio-science, material science and fusion applications. In this article, the

physics of the interaction of the microwave with magnetically confined plasma will be discussed and selected results will be presented.

Plasma, the 4th state of matter:

The term plasma comes from Greek, which means something molded or fabricated. It is also referred to as the 4th state of matter, and is defined as a quasi-neutral aggregate of electrons, ions and neutral species showing a collective behavior. About 99% of our visible universe is in the plasma state. Stellar interiors, gaseous nebulae and much of the rarefied interstellar atmosphere are examples of plasmas. A plasma is characterized by its particle (electron, n_e and ion, N_i) density and temperature (T_e

and T_i), which determine most of its properties. Please refer to chapter-1 of "Introduction to Plasma Physics and Controlled Fusion: Volume 1" by Francis F. Chen for more details on basics of plasma.

All known elements can be transformed to the plasma state by supplying sufficient energy so that the electrons are separated from the atoms. In order to sustain the plasma state, energy must be continuously supplied to the system to counterbalance the recombination of the electrons with the ions. In laboratories, plasma is generated mostly from gaseous elements. Liquids and solids

have to be first converted to their vapor states before their ionization to plasma state. Plasma may be generated by, (i) application of high DC/AC voltage between two electrodes; (ii) delivering RF power via coil antennas; (iii) launching microwaves of

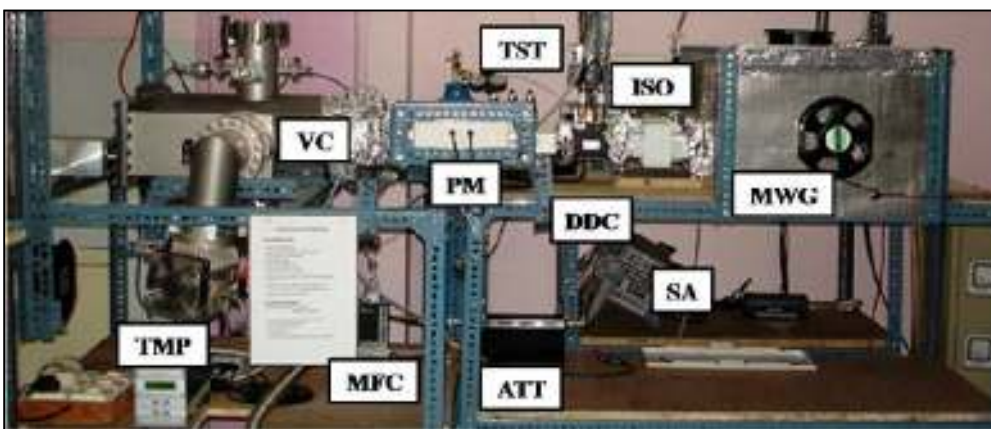


Figure 1: Experimental setup in the Waves and Beams Laboratory, Dept. of Physics, IIT Kanpur.

sufficient power via wave-guides/aperture antennas; (iv) Lasers. Laboratory plasmas are usually generated at low pressures (0.1 mTorr - 1 Torr), about 3 to 5 orders below the atmospheric pressure (760 Torr), depending on the scheme of generation and also the research requirement. Plasma at atmospheric pressure is also possible, and is currently being researched for various bio and environmental science applications. Magnetic confinement schemes enhance the plasma uniformity and lifetime in general, and also density and temperature in case of RF or microwave plasmas where resonance mechanisms come into play. Common confinement schemes include electromagnetic coils, multipolar arrangements, Tokamak configuration, etc.

Waves in plasma:

Plasmas can be regarded as gases with elastic fluid properties, i.e. when disturbed (usually electrically); they have restoring forces which bring them back to the equilibrium state. This restoring force is characterized by a plasma oscillation frequency (ω_p) related to the density (n) by

$$\omega_p = \sqrt{ne^2/m\epsilon_0}$$

where $n = n_e$ at N_i and m is electron (m_e) or ion (M_i) mass. Thus, electrons and ion respond differently to the disturbances since $M_i \gg m_e$, the ion usually forming the restoring background for the more responsive electrons. The restoring force is linear since the electric field varies linearly inside a volume containing uniform distribution of charged particles. The plasma also has a property called the Debye shielding, whereby any electrical anomaly or disturbance is shielded by the charged particles within a sphere of radius few times λ_D (Debye length), and must be considered while making current-voltage measurements for characterizing the plasma.

When an electromagnetic wave (EM) is imposed upon a plasma, the electrons and ions respond to the oscillating field, constrained by the restoring forces, with the electron being the primary respondent. This leads to various phenomena like whistler waves, Landau damping, various harmonic effects, etc. Imposition of a magnetic field on the plasma introduces new phenomena like the cyclotron resonance and damping, hybrid resonances and cut-offs, wave-mode conversions, and various non-linear effects. Studies on wave-plasma interaction enrich the understanding of the physics of plasmas and also pave the way for various applications.

The work carried out in our laboratory involves microwave generated, bounded plasma confined in cylindrical magnetic multipolar confinement. Multipolar devices in various configurations have been studied before. Most of the earlier works involved large volume devices. Many modern applications require, small volume devices, which have only been studied in the past ten years with emphasis on plasma sustenance and generation. The aspect of interaction between the wave and the plasma in such devices has not been studied in details. We are interested in experimentally studying how the microwave interacts with the magnetized plasma, and both the wave (frequency, wavelength, polarization, amplitude) and the plasma (density, temperature and energy distribution) parameters are mutually influenced.

We then try to corroborate the results and understand the physics involved from theoretical calculations and simulations.

Experimental setup:

A digital snapshot of the experimental setup is shown in Fig. 1. The experimental system consists of a stainless-steel Vacuum Chamber (VC) with four cylindrical arms having numerous ports for pumping, gas inlet, vacuum gauges and plasma diagnostics. The chamber is evacuated to a base pressure of 5×10^{-7} Torr by a combination of a Rotary and a Turbo Molecular pump (TMP). Argon (Zero grade) is used as the experimental gas, with its flow controlled by a mass flow controller (MFC). The working pressure range is between 0.20 – 0.60 mTorr which corresponds to about 10^{12} Ar atoms per cubic centimeter at 25 °C.

The microwave generator (MWG) generates continuous microwaves of frequency 2.45 GHz. The power range used in most of the experiments is 180 – 540 W. A three stub tuner (TST) is used for impedance matching between the source and the load (plasma). The forward and reflected microwave power is monitored by a dual directional coupler (DDC) and a power monitor (PM), and the isolator (ISO) dumps the reflected power to a water load and prevents damage to the MWG.

An eight-pole (octupole) magnetic multicusp (MC) of radius 42 mm and a surface magnetic field of 0.4 Tesla, is placed coaxially inside the VC. A thin stainless steel cylindrical shell is inserted inside the MC to provide a continuous conducting boundary condition. A MAXWELL simulation showing the magnetic field profile superimposed on a picture of the octupole arrangement is given in Fig. 2 (a). A radial plot

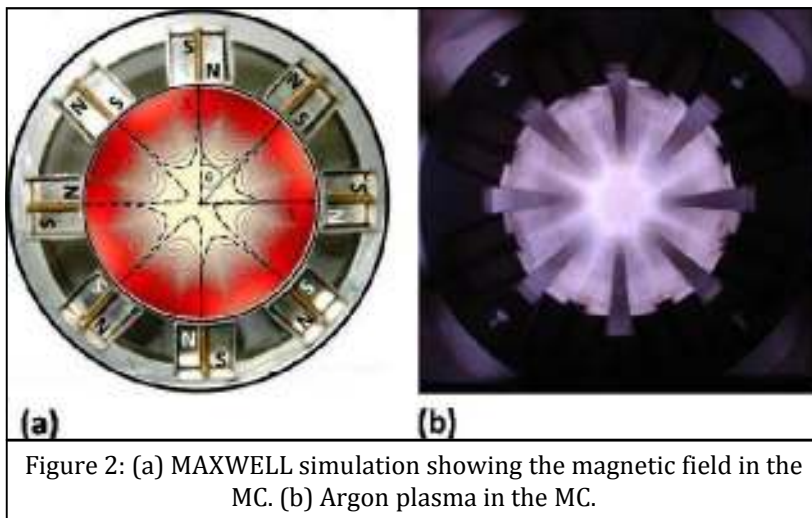


Figure 2: (a) MAXWELL simulation showing the magnetic field in the MC. (b) Argon plasma in the MC.

of the measured variation of the magnetic field,

$$|B_o| = \sqrt{B_r^2 + B_\theta^2}$$

where B_r and B_θ are the radial and polar components, is shown in Fig. 4. The axial variation of magnetic field is negligible. The magnetic field demonstrates a well like structure, with the magnitude of B_o minimum at the centre, and increasing towards the walls ($B_o \propto r^3$), and is hence referred to as a magnetostatic well.

Several probes for various plasma diagnostics such as charged particle density, EM waves etc., are introduced into the chamber, from both the radial and axial directions. A Langmuir probe is used for the current (I)-

voltage (V) characterization of the plasma. The ion density and the electron temperature are obtained from the I-V characteristics by standard procedures. A linear antenna with a small exposed coaxial tip enclosed in a pyrex glass tube is used for the measurement of the oscillating electric field. The probe signal is attenuated and measured with a spectrum analyzer by recording the peak-power corresponding to 2.45 GHz. All the probes are vacuum sealed inside thin stainless steel pipes and inserted via Wilson seals. The dimensions of the probes are chosen such that they cause minimal disturbance to the plasma during measurement.

Plasma generation:

When the microwaves of ~ 180 W is launched inside the MC, having Ar at $\sim 10^{-4}$ Torr, the very low population of free seed electrons present are accelerated by the oscillating field, and collide with the neutral atoms. The collisions, which are mostly elastic, randomize the phase of the electrons and they gain energy stochastically, until they have enough energy to excite or ionize the atoms. The process of excitation creates metastable atoms, which may be ionized by low energy electrons. The process of ionization generates electrons and ions, thus furnishing more electrons which participate in the above process. This leads to an avalanche characterized by a crossover point, after which the ionized gas becomes a full fledged plasma. The process is further enhanced in the presence of a static magnetic field, since the electrons perform helical motions thereby increasing their interaction probability with the atoms. The magnetic field in the multicusp is radially increasing towards the periphery. At about 28 mm from the centre, the value of the magnetic field (~ 875.5 gauss) is such that the electron cyclotron frequency given by

$$\omega_c = eB_o / m_e$$

becomes equal to the wave frequency, thereby leading to a maximum transfer of wave power to the electrons, which are accelerated to large energies, which enhances the process of plasma formation. As the plasma is created, the magnetic well like structure helps to confine the plasma along the central axis of the plasma by mirror and cusp actions. A digital snap of the plasma confined in the MC is shown in Fig. 2 (b). Thus, a radially inhomogeneous, high density plasma is generated in the multicusp in the presence of a radially increasing magnetic field.

The incident microwave thus interacts with an inhomogeneous magneto-plasma bounded by a conducting surface, leading to various interesting phenomenon, which are investigated experimentally.

Experimental results:

Figure 3 shows the radial variation of the plasma parameters (N_i and T_e) at different pressures, with the input power fixed at 180 W. It is observed that the density N_i is maximum at the centre, and falls off at the periphery. The density is a little higher at higher pressure, since there is more number of neutral Ar atoms that can be ionized. However, at much higher pressures, the increase in collisionality reduces the energy gain by the electrons, thereby decreasing the density. There is an optimum pressure range in which the densities are maximum for a resonance based plasma source. The temperature T_e demonstrates peak ~ 22 mm, signifying a wave - magneto-plasma resonance coupling. The magnitude of T_e decreases at higher pressure due to the increased electron - neutral collisionality. This is more prominent at the resonance zone, where the electrons are more energetic and hence undergo more collisional interaction.

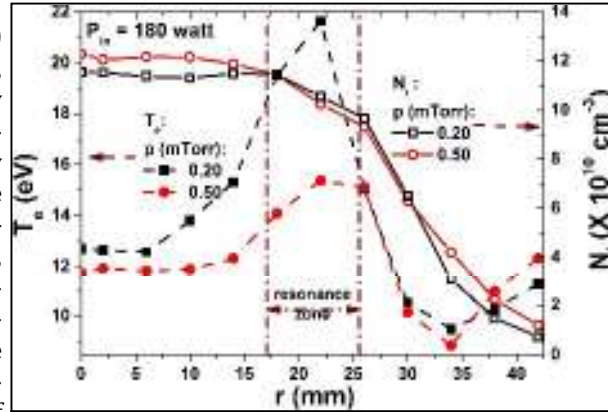


Figure 3: Radial variation of plasma density and temperature

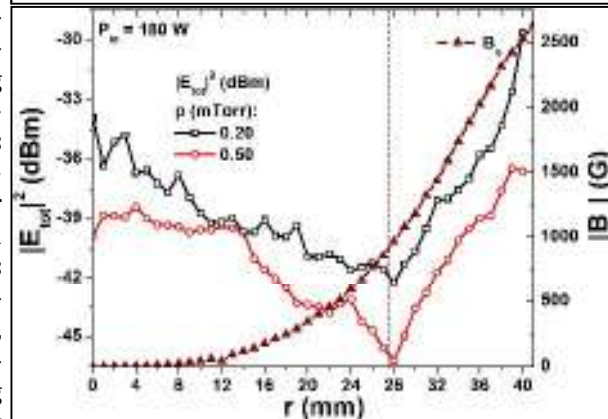


Figure 4: Radial variation of the intensity of the microwave electric field.

From the magnitudes of N_i and B_o in the multicusp, the refractive index of the magneto-plasma medium can be calculated. Since, most of the plasma applications involve geometries where the wavelength of the EM wave (l_o) is much smaller than the vacuum cut-off wavelength (corresponding to the dominant mode) of the confining boundary (l_c), the plane wave dispersion relations may be used for calculations, and give pretty accurate

results. According to that approximation, there should not be any propagation of waves by any mode through the central region, upto a radius of about 20 mm, since the $w_p > w$ of the wave (no ordinary mode), and the w_c is very small (no extraordinary mode). However, the measurement of the oscillating electric field intensity $|E_{tot}|^2$ shows (Fig. 4) that there finite propagation through the central plasma. A minimum is also observed at ~ 28 mm, which matches with the electron cyclotron damping point, where the wave transfers maximum energy to the electrons.

Discussions :

The penetration of the wave in the central forbidden region in our experiments is attributed to the reflections

from the confining boundary of the MC. The dimension of the MC is such that l_o (@ 12 cm) \sim l_c (@ 14 cm, for TE₁₁ mode). Hence, the waves which propagate inside the cylindrical waveguide via reflections, has a high degree of penetrability since the plasma cross-section is not large enough to damp the fields. In large waveguides, the fields will be damped out, and their radial field profile will tend towards the prediction of the plane wave model.

To predict the field profile in such small MC configurations, Maxwell's equations were solved by taking the magnetoplasma as a radially varying, complex dielectric medium, enclosed in a conducting circular waveguide. One such result where two different numbers of magnetic poles (6 and 8) in the MC is compared is shown in Fig. 5. The density and magnetic field conditions are similar to what we obtain in our experiments. It is interesting to note that a wave resonance peak is predicted

for the octupole case at \sim 23 mm, which coincides with the T_e peak in Fig. 3. Calculations show that this peak is dependent on both the plasma density and the magnetic field, and hence is a modified upper hybrid resonance for bounded, inhomogeneous medium. However, no such prominent peaks are visible in the experimental data in Fig. 4 because, the calculations are based on linearized approximations, and do not consider the various nonlinear, collisional and non-collisional wave-plasma interactions, which dissipate the wave energy at the upper hy-

brid resonance. In reality, a resonance actually occurs in that region, but the energy is coupled from the wave to the plasma, and is observed as a peak in the electron temperature, rather than in the wave intensity.

The research findings reported in this article have important significance with respect to design and optimization of compact multicusp based plasma sources for various applications.

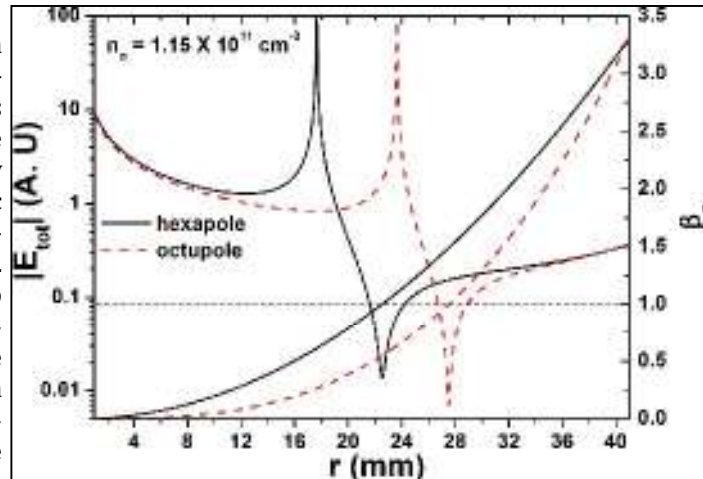


Figure 5: Calculated field intensity variation for two MC polarities.

Depending on the requirement of the application, the pole number, radius, even the conducting boundary may be selected based on the experiments and the corresponding calculations. In fact, the design for the plasma sources in both the indigenously developed FIB and NIB in the Waves and Beams Laboratory, are based on the above results. It is hoped that similar basic physics studies on the wave-plasma interaction in compact multicusps will lead to many groundbreaking developments in the research on the FIB and NIB, and will open up new horizons in the field of nano-science and technology.

developments in the research on the FIB and NIB, and will open up new horizons in the field of nano-science and technology.

Indranuj Dey (indranuj@iitk.ac.in) is a research scholar working in the field of microwave generated magnetically confined plasmas under Dr. S. Bhattacharjee in the Department of Physics, IIT Kanpur. He is interested in nonlinear wave - plasma interactions and its application to nanotechnology, space - propulsion and fusion.

Science Journalism and Communication Workshop

"It is suicidal to create a society dependent upon science and technology in which hardly anybody knows anything about science and technology", Carl Sagan, the eminent science writer once said. Today, with the rapid developments in science and technology impacting the society and environment we live in, science journalism and communication is growing as a specialist field of scientific expertise and as a creative and lucrative profession/career option for science/engineering graduates, but this field suffers from a paucity of talent all across the globe.

Workshops on Science Journalism and Communication were conducted by the founding Student Coordinator and Editor of NERD, Mohit Kumar Jolly, during Techkriti'10 (Annual technical and entrepreneurship festival of IIT Kanpur) and Tryst'10 (Annual technical festival of IIT Delhi). The workshop covered some basics of science/technology journalism and communication - What is science journalism and communication and what do science communicators do, various modes and means of effective science communication - interface of science and media, why is this field gaining importance in India and abroad, what challenges exist and what are the career opportunities for science/engineering graduates in this field, how can students get started into this field right away through freelancing or other means etc.

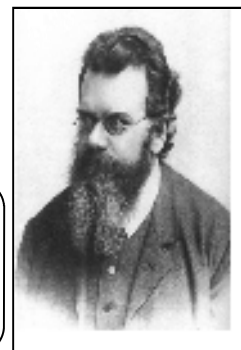
Various modes of journalism/communication- print (magazines/newspapers/popular science books), video (documentaries/TV shows), audio (radio scripts), science cartoons, public debates shall be taken as examples to bring to light the need for different modes depending on the audience and the content.

For more details about the workshop and science journalism, please contact Mohit: mkjolly.15@gmail.com or 9044274258.



Brightness and Contrast

Michael Faraday and Ludwig Boltzmann



Two of the greatest minds in the world of science had one thing in common-creativity. Sadly, the respect that their work received couldn't have been more different; While one was offered knighthood and much more by his contemporaries, the other committed suicide after a lifelong battle against the disapproval of his work by a vocal, group of physicists of his era.

Ish Dhand

Michael Faraday

Michael Faraday was born on September 22, 1791 at Newington, England to a blacksmith father and a mother who was a farmer's daughter. Faraday received very basic education up to the age of 13 when he had to give up school because of the family's financial condition. He was employed by a kind bookbinder and bookseller, Riebau, who, as is popularly known, let him read the books he bound.

In the words of Faraday: *"There were two that especially helped me, the 'Encyclopedia Britannica' from which I gained my first notions of electricity and Mrs. Marcet's 'Conversation on Chemistry', which gave me foundation in that science."*

Faraday's brother Robert paid for his subscription to become a member of the City Philosophical Society which organized a series of evening lectures on natural philosophy. Soon, he found himself attending series of four lectures with Humphrey Davy as the speaker at the Royal Institution. His carefully prepared, illustrated and bound notes were not enough to convince Humphrey to provide an opportunity to work on his passion in science, until Humphrey's lab assistant was dismissed from his job for indulging in a public brawl and this is where we see the beginning of the career of one of the greatest geniuses in experimental science with work ranging from Electromagnetic Induction to the discovery of benzene. An 18 month long scientific tour in which he accompanied Davy exposed him to the greatest men of science of those days and had an important influence on him: that of broadening his horizons.

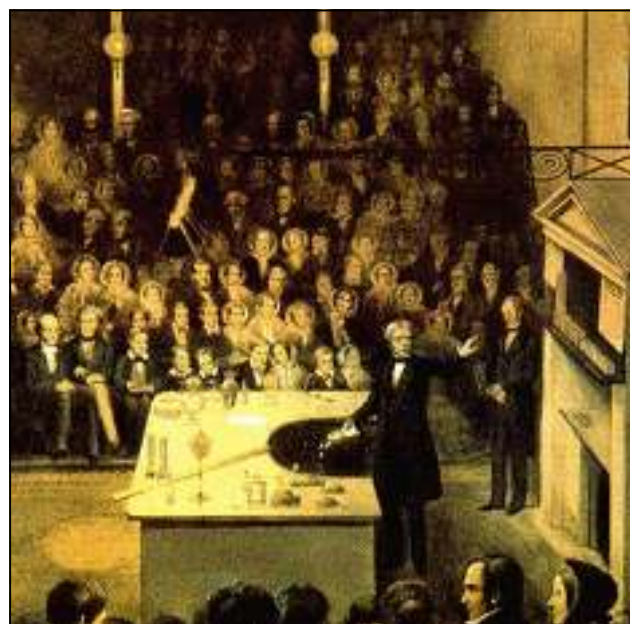
His early work in the Royal Institute focused on research in Chemistry. In 1822 he made the first steel alloy. Faraday was also the **first to liquefy a gas, chlorine**. He **discovered benzene** (C_6H_6) while examining the residue collecting in cylinders of illuminating gas in 1825.

His work in the field of electricity and magnetism is more fundamental. In 1821, taking inspiration from Oersted's observations, he demonstrated the first form of an **electric motor**. Though, today, we have evidence of the originality of Faraday's work, Davy's conviction that Faraday had actually stolen his idea led to a rift between

Faraday and him that just didn't heal. Faraday then moved on to observing, understanding and using the effect we today know as **Electromagnetic Induction** wherein relative motion between a magnet and a wire produces current in the wire. The dynamo's used to power all our homes are attributed to the effort put in by him during this phase of his life. Faraday's work in electrochemistry gave us the **first ideas of the anode, the cathode, anions and cations**, all of which are terms popularized by Faraday himself in order to explain his work.

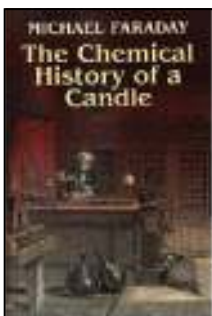
An idea put forward by Faraday was the **notion of Fields** to describe the Electromagnetic interactions and this has been the cornerstone of modern electromagnetic theory. Faraday also found that the plane of polarization of linearly polarized light can be rotated by the application of an external magnetic field aligned in the direction the light is moving. Faraday discovered **diamagnetism** in 1845 when he observed that many materials exhibit a weak repulsion from a magnetic field.

Along with all this, he was a great expounder of science to popular audience. Under the Friday Evening Discourses, Faraday delivered more than a hundred lec-



tures which reported the developments in science to a

general Audience. In 1826, he started the Lecture course: a series of six Christmas lectures for children. Of the nineteen of these he delivered, two, 'The Chemical History of a Candle' and 'Lectures on Various Forces of Matter', were published and have become classics.



Perhaps teachers would agree with the views of this great scientist who painstakingly prepared to make himself one of the greatest lecturer's of his time.

"As practiced by the Society, lecturing is capable of improving not only those who are lectured, but also the lecturer. He makes it, or he ought to make it, an opportunity for the exertion of his mental powers, that so by using he may strengthen them; and if he is truly in earnest, he will do as much good to himself as to his audience."

"A lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him and his mind clear for the contemplation and description of his subject. His action should be slow, easy and natural, consisting principally in changes of the posture of the body, in order to avoid the air of stiffness or sameness that would be otherwise unavoidable."

"With respect to the action of the lecturer, it is requisite that he has some, though it does not here bear the importance that it does in other branches of oratory; for though I know of no other species of delivery that requires less motion, yet I would by no means have a lecturer glued to the table or screwed to the floor. He must by all means appear as a body distinct and separate from the things around him, and must have some motion apart from that which they possess."

"The lecturer should give the audience full reason to believe that all his powers have been exerted for their pleasure and instruction."

During his lifetime, Faraday rejected a knighthood and twice refused to become President of the Royal Society.

"I have always felt that there is something degrading in offering rewards for intellectual exertion, and that societies or academies, or even kings and emperors should mingle in the matter does not remove the degradation".

Faraday breathed his last on 25 August 1867. Following his wishes he was buried quietly, instead of the Westminster Abbey, in Highgate cemetery.

Ludwig Eduard Boltzmann

Ludwig Eduard Boltzmann was born in February 1844 in Vienna to a comfortable middle-class family. At the age of 15, he lost his father. He received his primary education

from a private tutor at home following which he studied physics at the University of Vienna, starting in 1863.

We owe much of the understanding we have of the microscopic world, ranging from the very **idea of the atom**, to the **perception of entropy** as something that can be 'counted' and to insights into the **meaning of temperature**, to Boltzmann. His contributions today are accepted as fundamental, but during his age, he was met by a very vocal opposition from a many renowned scientists, including Ernst Mach, who is considered as the precursor to Einstein's relativity and Wilhelm Ostwald, who is credited with the invention of the Ostwald process for the manufacture of nitric acid and the Ostwald dilution law.

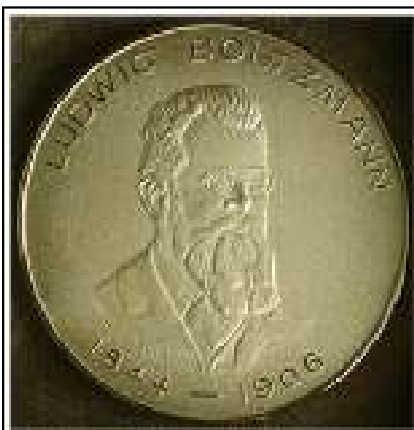
Boltzmann completed his doctorate from the University of Vienna in 1866 with his thesis on the kinetic theory of gases supervised by Josef Stefan following which he became an assistant to his teacher. This theory explains the macroscopic properties of gases using the assumption that gases are made up of a large number of small particles (Molecules or atoms) and analyzing the interaction between them using the existing laws of mechanics. Boltzmann, throughout his life, faced severe repulsion from some parts of the scientific community who did not believe in the atomic hypothesis.



Stamp issued by Austria in 1981 to acknowledge the fundamental contribution of Boltzmann to

In 1869, Boltzmann was appointed the Chair of Theoretical Physics at the

University of Graz. Four years later, he accepted the Chair of Mathematical Physics in the University of Vienna. He did not stay very long in one place and in another three years, he found himself back in Graz, now, in the Chair of Experimental Physics. In 1894, the death of his teacher, Stefan, saw him moving to Vienna to fill the vacancy in the Theoretical physics chair there. Owing to the friction between him and Ernst Mach, who was appointed to the chair of history and philosophy of science in the same university, he left for the university of Leipzig to become a colleague of friend but nonetheless, a persistent opponent in scientific matters, Wilhelm Ostwald. As his opponents pressed violent argument against his fundamental work in Statistical Mechanics, he unsuccessfully attempted suicide while in Leipzig. It is unclear whether it was because of the loud opposition that his theories received from some scientists, or a simple physiological condition, but it is clear that he was undergoing through serious depression. He eventually commit-



The Boltzmann award was instituted by the International Union of Pure and Applied Physics (IUPAP) Commission on Statistical Physics to honour outstanding achievements in Statistical Physics.

many fundamental contributions to the field of statistical mechanics. In 1871, he extended the work of Maxwell and gave meaning to temperature by showing that the **energy possessed by each atom/molecule in a gas is proportional to the temperature**. Joseph Stephen, his teacher had, based on experimental evidence, formulated the **T⁴ law for Blackbody radiation**. In **1884, Boltzmann provided a theoretical derivation** for the same based on the laws of thermodynamics. In the 1890's, Boltzmann gave a sound theoretical backing by **relating, probabilistically, the entropy of a system to the number of possible states** of the system. In this manner, Boltzmann justified the 2nd law as a law of disorder.

Using the laws of mechanics, coupled with the probabilistic arguments and some basic assumptions, Boltzmann showed how we could talk about macroscopically measurable quantities in terms of basic microscopic ideas. This made many uncomfortable in science circles who still considered that it was energy and not atoms as the chief component of matter.

The idea of probability was also seen skeptically in a

ted suicide in 1906 while he was on a vacation with his wife and children. Perhaps, only to add more drama to the picture, one year after Boltzmann's death, his scientific beliefs, including the atomic view, saw a clear victory in light of the work done by Einstein, Smoluchowski, Perrin et al.

Through a rather unstable career, Boltzmann made

time when determinism was considered sacrosanct. Boltzmann explained irreversibility, in thermodynamic systems, based on reversible mechanical laws and this, again, caused discomfort to his contemporaries based on their philosophies.

Boltzmann understood the nature of the school of science and philosophy rather well: *"The most ordinary things are to philosophy a source of insoluble puzzles. With infinite ingenuity it constructs a concept of space or time and then finds it absolutely impossible that there be objects in this space or that processes occur during this time . . . the source of this kind of logic lies in excessive confidence in the so-called laws of thought."*



Viennese Zentralfriedhof

Boltzmann's suicide in 1906 does intrigue one about the nature of scientific discovery. He is buried in the Viennese Zentralfriedhof; his tombstone bears the inscription $S = k \cdot \log W$.

Following sources are acknowledged for the images used in this article :

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The new NERD HERD

The founding student coordinators of NERD, the student-led initiative of the campus science and technology magazine - Arvind Kothari and Mohit Kumar Jolly - handed over the reins to the newly constructed CCC (Core Coordination Committee) of the project-Bhuvnesh Goyal, Pranjali Nayak and Utsav Kesarwani. Dr. Anurag Gupta has kindly agreed to be the new Project Coordinator and he shall soon take over from the founding Project Coordinator Dr. M. K. Harbola. NERD has flourished as a project under guidance of Dr. K. Muralidhar, Dean Research and Development, IIT Kanpur. NERD, first launched on 5th September, 2008 has had 7 issues published till now, including a special issue on Energy and Environment, which was launched in Techkriti (the annual technical and entrepreneurship festival of IIT Kanpur) 2009.

The new NERD HERD is grateful to all NERD team members who contributed in establishing it as a successful experiment in campus.

(continued from page 27)

The golden ratio can also be found in many musical compositions of Mozart, Beethoven etc. mainly because it is a natural way of dealing with divisions of time. Composers like Debussy and Bartok have intentionally used this ratio and the Fibonacci series. Bartok deliberately writes melodies which contain intervals whose sizes can be expressed in Fibonacci numbers of semitones.

No, The Golden ratio is not an ancient thing to inculcate in all the things, even nowadays, the web designing is done. A simple design of a web page uses the golden rectangle (Fig. 2).

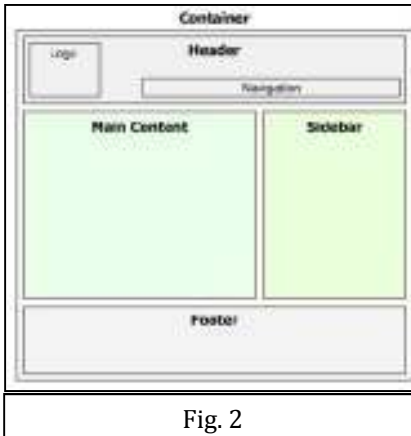


Fig. 2

Our fingers have three sections. The proportion of the first two sections to the full length of the finger gives the golden ratio.

There are many golden ratios in the human face. Now do not pick up a ruler and try to measure people's faces as this refers to the "ideal human face" determined by doctors and scientists.

For example, the ratio of total width of the two front teeth in your upper jaw with their height gives a golden ratio. Some other golden ratios in the human face are:

a) Length of your face and the width of

your face,

b) Length of your face and the distance

between tip of jaw and point where your eyebrows meet,

c) Length of your mouth width of nose,

d) Width of your nose and the distance between nostrils,

e) Distance between pupils of your eyes and the distance between eyebrows.

We, the humans, are not the only one to design our things and composition according to the Golden ratio, seems like the God enjoys this logic too. Let us see how. First of all let us take a pine cone and count the clockwise and counter-clockwise direction. Secondly take a pineapple and count its spiral too. Now it's turn of a sunflower, count its spiral too. No, I have not turned into a crazy "nerd", but I simply want to put forward the beautiful designing. In the case of pine cone the ratio will come out to be 8:5

which is 1.6. And in case of pineapple it's $13:8 = 1.625$. And now you will be startled, in case of sunflower it is $55:34$, $89:55$, or $144:89$ and they are approximately, in order: 1.61765, 1.61819, and 1.61798. Yes!!! The ratio is going closer to the Golden Ratio.

Now, let us come to the human body (Fig. 3). Take a good look at yourself in the mirror. You'll see that most of the body parts follow the numbers one, two, three, five and eight. You have two hands, fingers on them comprises of three sections. There are five fingers on each hand and feet, golden number: 2, 3 and 5 fit the Fibonacci series. DNA molecules having length of 34 angstrom and width 21 angstroms for each complete cycle of the double helix follow this series too.

The distance between your shoulder line and the top of the head length, the distance between your navel and the top of the head and the distance between the shoulder line and the top of the head and the distance between your navel and knee and the distance between the knee and the end of the foot also follow.

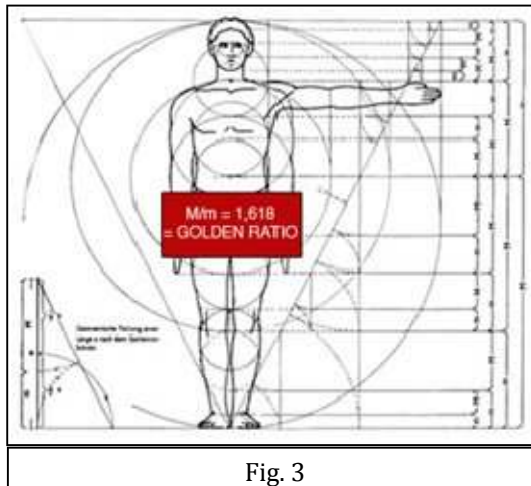


Fig. 3

various long and short variations and projections that comprise the snow flake all give the golden ratio.

The golden ratio can also be seen in crystal structures. Most of these are structures too minute to be seen with the naked eye. Yet we can see the golden ratio in snowflakes. The



Fig. 4

In the universe there are many spiral galaxies comprising the golden ratio in their structures. When investigating the shells of the mollusks (Fig. 4), which thrive at the bottom of the sea, the shells of these animals was also found to grow in golden ratio manner.

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1. http://www.world-mysteries.com/sci_174.jpg
2. <http://library.thinkquest.org/trio/TTQ05063/phibeauty3.htm>
3. <http://library.thinkquest.org/18054/data/text/english/e03.html>
4. http://en.wikipedia.org/wiki/Golden_ratio
5. <http://www.world-mysteries.com/>

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SCOPE talk series

(Science Communication and Public Engagement)



'Scientoons: Enjoy science with fun'

Dr. Pradeep Srivastava, Senior Scientist in the Medicinal and Process Chemistry Division at the Central Drug Research Institute, Lucknow, gave a lecture titled "Scientoons: Enjoy Science with fun" on 19th September, 2009. Dr. Srivastava developed the field of Sci-

entoonics while delivering a lecture in 1988 at an Asian conference at NUS, Singapore. He was awarded the International Young Person of the Year Award by the Junior Chambers Association (USA). Sci-entoonics is a new branch of science which deals with effective science communication using a novel class of science cartoons called Scientoons. Sci-entoon not only make you smile and laugh but also provide information about new research, new subjects and concepts in a simple, understandable and interesting way.



'Science communication in India'

Dr. Manoj Patariya, Director of National Council for Science and Technology Communication (NCSTC), DST and the President of Indian Science Writers' Association (ISWA) gave a lecture

on "Science Communication in India" on 19th September, 2009 where he talked about what exactly is science communication, what is its present state in India, what measures have been taken to make the common people realize the significance of science, and to build a scientific temper among them, what are the challenges in this area and what is the future vision of science communication and journalism in India. Dr. Patariya, the editor of Indian Journal of Science Communication (IJSC), holds a PhD in science communication and has received the prestigious B. C. Deb Memorial National Award for Popularisation of Science by the Indian Science Congress Association in 2000.



'Trash to treasure'

The bearded man in *khadi kurtaa* **Mr. Arvind Gupta** is a toymaker. You may call him a magician as well. He has taught hands on science and toy-making workshops to thousands of children throughout India, and has

written his trash-to-treasure lessons written in numerous books, all freely available at www.arvindguptatoys.com.

When he took out his '*jhola*' in the jam packed lecture hall on January 3, we got a glimpse of what has been **revolutionizing science teaching in India**—dozens of toys as whirling thread rings, tone-changing flutes, wall-

climbing critters etc. in a small plastic *dabba* full of thread, buttons, scissors, straws, matchboxes, marbles, empty ball pen-refills, and other throwaway items.

He is a Distinguished Alumnus Awardee of IIT Kanpur, a **UNESCO consultant on science education** and winner of India's National Award for Science popularisation.

'Bull Scientifique'



Mr. Abhay S D Rajput, a research associate (journalism) at Indian Council of Agricultural Research (ICAR), has been a **S. Ramaseshan Science Writing Fellow** at the journal *Current Science*. Author of '*Handbook on science journalism*', he has extensive experience in communicating

science through radio, films and print since 2005.

He gave introductory lecture on science communication, on January 16, where he talked about the need and scope of the field and career opportunities in the same. He has received Rajat Jayanti Science Communication Award 2008 by Department of Science & Technology, and holds a masters in science communication from DAVV, Indore.

'Science, Media and risk - the intricate relationship'

Ms. S. Priyadarshini, Editor, Nature India- one stop site for information on Indian science, delivered a talk 'Science, media and risk - the intricate relationship' on February 24, 2010.



The talk introduced science journalism - why it is needed at all, its status in India and abroad and basics of science news reporting and editing, and necessary precautions required before publishing any science related story in media, through enough anecdotes and examples of science news to show how science news is presented. The talk also gave an overview of the scope of the field of science journalism - how students can start contributing articles for science news portals/newspapers by free-lancing, how faculty members, without disturbing their research work, can get their work across to the media, how should the interaction of a scientist be with media, and last but not the least, the future of science journalism as a career option for those interested.

Winner of BBC World Service Trust award for environment reporting, Ms. Priyadarshini has covered science news for The Indian Express, The Telegraph, The Asian Age, Press Trust of India and has been Science Editor, Down to Earth—India's only science and environment magazine.

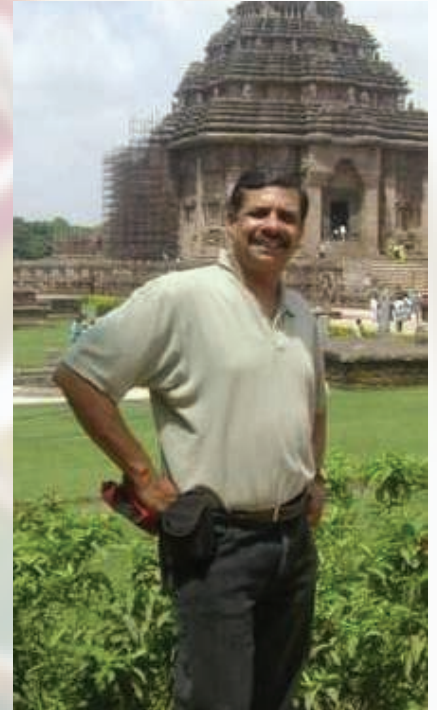
Reminiscences

Dr. Ramamurthy Balasubramaniam, professor in the department of Materials and Metallurgical Engineering at IIT Kanpur passed away on December 9, 2009. Born in Salem, Tamil Nadu, he obtained his PhD in Materials Engineering in 1990 from Rensselaer Polytechnic Institute Troy, USA. He joined the faculty of Materials and Metallurgical Engineering at IIT Kanpur on 2nd April 1990.

His research interests included Material-Hydrogen Systems, Environmental Degradation of Materials, Structure-Property Correlation in Advanced Materials and Indian Archaeometallurgy. He was a prolific researcher and has published more than 250 research papers in refereed journals of repute. He has published 10 books. Two of his recent books "The Saga of Indian Cannons" and "Story of Delhi Iron Pillar", which dealt with Indian Archaeometallurgy are on corrosion resistance. His research on the of Delhi's iron pillar attracted worldwide attention. One of his most recent research projects was his work on Corrosion Prevention of Rails under the Technology Mission on Railway Safety.

In recognition to his outstanding contribution as an active researcher in the field of Metallurgy, Materials Science and Archeometallurgy, Dr. Balasubramaniam received a number of prestigious awards, including Young Scientist Award (1993), Indian National Science Academy, Alexander von Humboldt Foundation Research Fellowship (1996), Materials Research Society of India (MRSI) Medal (1999), Metallurgist of the Year award (1999), Ministry of Steels and Mines, Government of India. He was a member of the National Commission for History of Science. He was an editorial member of a number of international journals in the area of corrosion and Archeometallurgy. He was one of the finest teachers and recently received the inaugural Distinguished Educator Award (2009) from Indian Institute of Metals (IIM). Dr. Balasubramaniam was a life member of Indian Institute of Metals.

Apart from Academics, Dr. Balasubramaniam was an enthusiastic sportsman with a passion for cricket. He also had a great passion, both for Indian and Western music, right from his student days in BHU. NERD team wishes that his departed soul may rest in peace.



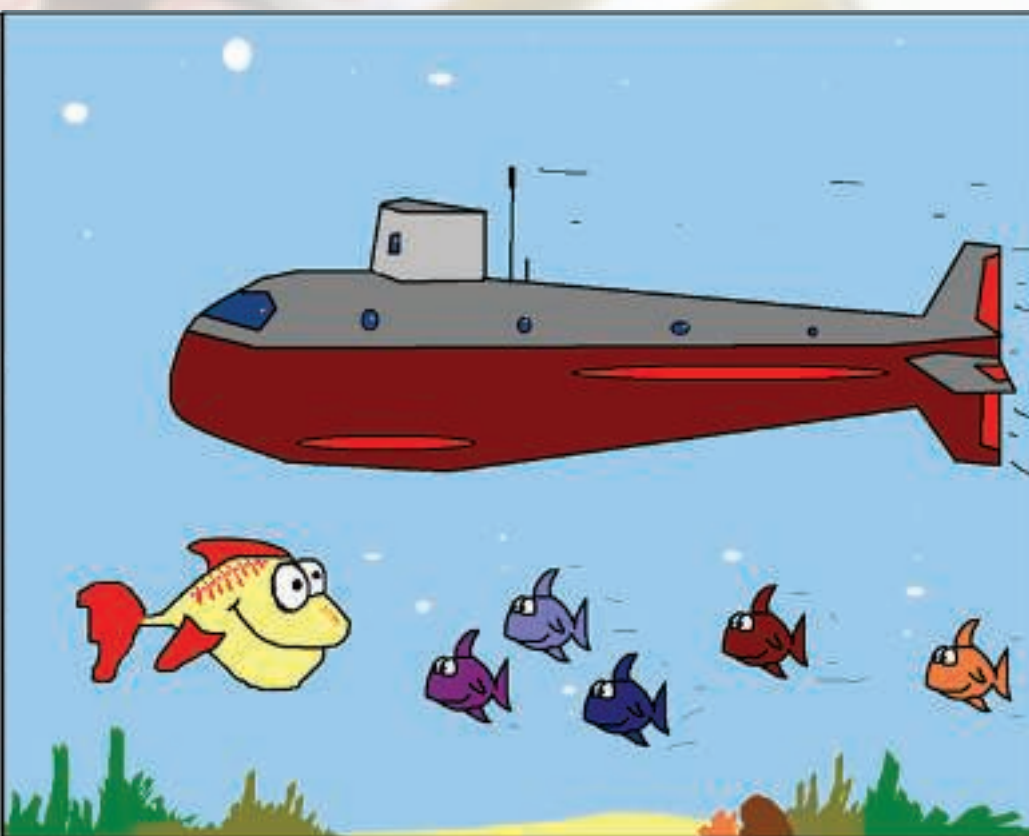
Dr. R. Balasubramaniam
1961-2009

CALL FOR ARTICLES

NERD is the scientific and technical research and development magazine run by the students of IITK. We publish news on scientific breakthroughs happening in various technical education institutes, research labs et cetera across India and the world with an emphasis on the work done by students. So NERD is a magazine of the students, by the students, for everyone. The NERD magazine is first of its kind and we need everyone who is interested in science and technology to be on our team. Join "the NERD Herd!" Yes, you can be the one writing for the magazine.

SCIENTOON—by Puneet Singh

INS Arihant (S-73) is the lead ship of India's Arihant class of nuclear-powered submarines. The symbolic launch ceremony for the Arihant was held on July 26, 2009 marked the anniversary of Vijay Diwas. The 5,000–6,000 tonne vessel was built under the Advanced Technology Vessel (ATV) project at the Ship Building Centre in Visakhapatnam. Full integration of key systems and Sea trials are expected to be extensive. The completion of the INS Arihant will make India one of six countries in the world with the ability to design, build, and operate its own nuclear submarines.



"This children, is a new animal that our scientists have discovered. Instead of eating seaweed or plankton, it eats the dangerous element Uranium and engages in fights with members of its own species"

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