



Notes
on
Engineering
Research
and
Development

Biologically Inspired Technologies
Biomimetics

**ATLAS SHRUGGED :
GLUCO-BAND**



Evolutionary Computing

It Happened Here - Bio-inspired Patterned Adhesives

Interviews with Dr. H. C. Verma and Dr. Frances Allen



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Student Co-ordinators : Arvind Kothari [(arvikot@) 9936186872]
Mohit Kumar Jolly [(mkjolly@) 9305696301]

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Artwork : Prabha Mallya

Page design and layout : Soumya Misra

Cover page design : Rachit Rastogi

Webmaster : Pranav Sakulkar

Celebrating Student Research

Let's take a moment to congratulate ourselves! We, the students of IIT Kanpur, have just completed the circle. By deciding to read **Notes on Engineering Research and Development (NERD)**, we have become a part of a paradigm shift, an instrument of a great process: **Celebration of Students' Research**.

Every year students do a lot of activities that can be classified as research, but very rarely, it gets publicized. Due to this, the other students remain unaware of the excellent work done by their peers on campus. In the absence of such information, they lose interest in science and technology, and the research remains in library shelves and hence, inaccessible.

Where did the dream of becoming a scientist or an engineer go? It must have crossed at least once through their minds. How to enthuse ourselves about science, technology and research outside LHC? These are the pertinent questions. And we have provided the answer.... NERD. NERD is here to give the dream back. To give the assurance that science and technology are not slaves of lecture halls and books and that if the person living next door can do research in the form of excellent projects, thesis and experiments then why can not we? Research is doable! We have one thing in mind. We want to hype science, technology and research. We want to add glamour to them. Our target is to provide a been-there-done-that-aha feeling to people. For too long, research and its expression had been limited to labs, journals, conferences, as thesis documents in the library and project reports on shelves. For once, we want to deliver the message that **Think outside the Lab!** We want to bring research out, out from the labs to hostel quads, messes and the very rooms of the students. And naked! So that it is comprehensible to one and all. We want to **make research simple, but NOT simpler**.

NERD will be an exciting, **student-led initiative** aiming to broaden the scope of the scientific experience of students. It will provide opportunities for students to participate in the academic review and publication processes and a motivation to engage in research. Of course, help of faculty members is indispensable. Through NERD, we wish to bring in a sense of community amongst the faculty, students and other members of the campus community because that is the true spirit of journalism, scientific or otherwise.

However, clouds surround us. Will this initiative survive? And for how long? Sustenance is the biggest question that confronts NERD. And we all have to

provide the answer. We can either decorate our shelves with the magazine, use it as a mouse pad for downloading yet another TV series or we can read it cover to cover, and point out the mistakes, provide feedbacks, get inspired and write for the upcoming issues. We have to remember that the success or failure of this idea will measure our true potentials in the fast transforming knowledge economy. A measure of how far this institute and its stakeholders are willing to go in order to change the world. Not the new world, not the old world, but the next world.

So, Come on, join the team, come on board, Create, Communicate, Contribute. Remember the 4 Cs and be a part of this revolution. *Anyone willing to lead the change in the world in the next twenty years is welcome!*

FIRST ISSUE

The first issue of NERD is loosely centered around Biomimetics, biology inspired designs, a very happening field of research. The great thing is that our friends here at IIT Kanpur have done some exemplary work in the field, published papers in journals like Science, won competitions and courageously taken the work to the next level. The issue also features a view on pedagogical aspects of learning, accomplishments of women scientists against all odds and a refreshing take on evolutionary computing (biomimetics in computer science) by a first year Undergraduate student! A big round of applause is indeed well deserved by Shish Basu Palit, the author!

Feedbacks, bouquets and brickbats are welcome. Please direct them to nerd@iitk.ac.in.

ACKNOWLEDGEMENTS

Lot of efforts have been taken to bring NERD into reality and several people have played significant role. Congratulations are due to the core group of NERD that stuck together and worked so hard for making this idea come true. Keep up the good work! We would like to thank Professor K. Muralidhar, Dean of Research and Development for his patience and unequivocal support for the idea. We would also like to thank Ms. Avanti Joshi for her guidance through and through. We are grateful to all the faculty members who gave us time, provided feedback on the idea and agreed to help us by joining the Review Board. Last but not the least, we would like to acknowledge the help given by Counseling Service for publicizing the idea among new students.

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WIRED

This is the feedback column of NERD. Various comments, general or article specific, that we receive at <http://www.iitk.ac.in/nerd> or nerd@iitk.ac.in will be published here with occasional replies from the NERD. Feel free to express your views. Here are the comments that NERD received in its nascent stage:

"Great idea! I support it. Don't worry about the finances. The most important issue is sustainability and ethics of journalism. You should take responsibility for the content, rewards and criticism." **Professor K. Muralidhar, Dean, Research and Development**

"This is an excellent idea! I am ready to help in any way you think I can be useful." **Professor Manindra Agrawal, HOD, Department of Computer Science and Engineering, IIT Kanpur**

"Excellent proposal! This will be a good initiative at IIT Kanpur. It will go a long way in furthering science and technology, if this effort can be sustained organically for say ten years or so. Starting thing is easier than sustaining. You should build mechanisms and incentives so that it will last for at least a decade." **Professor Sunder Iyer, Department of Electrical Engineering, IIT Kanpur**

(continued on page 35)

What is Biomimetics?

One fine day in 1948, a Swiss engineer George de Mestral returned from a hunting trip with his dogs in the Alps. He was cleaning the burrs (seeds) of burdock (a broad-leaved weed) that were sticking to his dog's fur. He examined those burrs under a microscope and noticed hundreds of 'hooks' that clung on anything with a loop- be it clothing, animal fur or hair. He started thinking how to duplicate the hooks and loops, as he wondered if he could bind two materials reversibly in such a simple fashion. This realization led to the invention of Velcro- the brand name of fabric hook-and-loop fasteners, and a multimillion-dollar industry today.

This was not the first instance when *Homo sapiens* got inspired by engineering solutions of nature. Since life has been into existence, *Nature's inventions have always inspired human achievements and have led to effective algorithms, methods, materials, processes, structures, tools, mechanisms and systems. Biomimetics is the study and imitation of nature's methods, designs and processes.* (Yoseph Bar-Cohen) The term Biomimetics was coined in 1969 (*bios* meaning life, and *mimesis*, meaning to imitate). This emerging field of engineering covers biologically inspired as well as biologically mimicked technologies. Nature and engineering have one objective in common- maximum utilization of resources with minimum expenditure of energy.

Being such a new area of technology transfer, Biomimetics offers a plethora of opportunities for people to make discoveries and transform them into successful patents. Pragmatic natural solutions developed by evolution are rapidly improving the efficiency of human designed products and systems in today's era.

Have you heard of 'smart' clothing that adapts to changing temperature? Julian Vincent has developed it recently. Inspiration? The Pinecones -they respond to warmer temperatures by opening their scales. So does the smart clothing- opening up when it is warm and shutting when cold. This was one of the projects at the World Expo 2005 in Japan.

Enjoy more Biomimetics in the articles ahead!!

CycleMAN

You all must have watched on TV and emulated Spiderman, Batman, Shaktiman, Aryaman, He-Man and what not! IIT Kanpur presents to you its own 'CycleMAN'.

Walking in around the campus, did you ever catch sight of a person riding on a 'weird' motorized vehicle? The NERD Core Team member, *Kunwar Apoorva Singh*, talks to *Mr. Saurav Saket*, a research assistant in the *Center for Mechatronics*, who is seen riding on the roads of IIT Kanpur, on his self-made motorized cycle. He can ride it at a top speed of 30kmph. It can run for about 40 kilometers at a time, once it is charged well for 7-8 hours.

Let's ask Saurav about his cycle, which he made at the end of 3rd year of his B.Tech from Maharana Pratap College of Technology (MPCT) Gwalior. Initially, he made a cycle by welding iron pipes but soon realized that high temperature welding makes iron soft and brittle, thus making the cycle prone to breakdown on a bumpy road. Finally, he decided to buy a cycle and to try his experiments on it for his endeavor of a motorized cycle. He bought one for Rs. 5000 and mounted a motor on it. The next challenge was to mount batteries as they were heavy. When a high speed cycle tries to stop, excessive weight on one tyre makes that tyre rub more on the road surface and in a few turns, the tyre blasts. Thus, considering average weight of a human being, an appropriate place for battery was chosen so that overall weight remains same on both the tyres. Now, he uses a potentiometer to vary voltage across the motor in an analog fashion and controlling the cycle speed and normal disc brakes.

The cycle is configured with a maintenance free 12v 7 AH *6 battery, ½ hp motor and tubed tyres. Saurav is working on ways to

improve his cycle- by replacing the existing battery with lithium ion battery which weighs less and lasts longer. The cycle uses timing chain of the automobile engine and is hence prone to chain break. He wants the current gear system to be changed into two stage gear reduction so that the tension on the chain reduces and its lifetime increases.

Our CycleMan leaves us with a message: "You can learn a lot of things from things around you, if you try it. Engineering is not to have all the things and then make something, but it's to make a lot of things from nothing." Contact him at sauravsaket@gmail.com.

Ponder Yonder

The Head of Center for Mechatronics at IIT Kanpur is Mr. Susmit Sen. He can be reached at sens@iitk.ac.in. Further details about the Center for Mechatronics can be found at <http://www.iitk.ac.in/robotics/>



Saurav Saket on his motorized cycle

Kunwar Apoorva Singh (kasingh@iitk.ac.in) is a second year undergraduate student in Mechanical Engineering Department. He is interested in Mechatronics (the combination of Mechanical Engineering, Electronic Engineering and Software Engineering). He is one of the two UG sophomores working on Nanosatellite Project.

Tried and Tested Ways

To make your ROBOT NOT WORK

Pratyush Pandey

Introduction

Whenever you try your hand at anything experimental, you end up learning, how things *don't* work – by elimination you get some idea about how things *might* work. This is outcome of a short time that I dabbled with robotics, and my experience related to making a simple line following robot for the intra IIT competition, Technokratics.

All of you must be having some idea of what a robot is. To put it in simple words, it is a mechanical artificial agent. Let's get familiarized with some basic terminology used in robotics.

- Microcontroller is the brain of the robot. You program the instructions into it, and the robot follows. The logic used by your computer (in which you code) needs to be converted into the logic used by the microcontroller.
- PCB (Printed Circuit Board) is the board in which you solder your circuit.
- V_{cc} is the high voltage point in your circuit. To provide a potential difference, you need two points – one is ground, the other V_{cc} .
- Multiplexers can be described as a kind of switch. For example, a 4x1 multiplexer has one input which, on the basis of two control inputs (two controls to control 4 outputs), connects the input to one of the four outputs. Ideally, when the input is not connected to the output, the voltage at the output should be zero. Practically, this is not the case – we get floating values.
- Normally, PWM (Pulse Width Modulation) is a square wave pulse given as an input to the motor, but with different low and high times to control the average voltage output.
- Many chips have a Reset pin. What it does is quite simple – it resets the chip if the pin goes high. It is suppose to stop disasters, but usually causes them.

Now, let me tell what steps will not let your robot work.

Ways to destroy your robot

1. Let's start with the easiest way to make your circuit malfunction: connect your ground and V_{cc} somewhere in the circuit while soldering. You detect this when a chip blows, or if you're cautious enough and do a connectivity check before switching on the power. The way out is to clean the places where there are chances of connection by something like an aligner. If this doesn't help, use an iron for cleaning. If even this doesn't help, you're in HARD luck. Desolder, from the bottoms up, the connections (meant in an organizational chart fashion) and when the short disappears, you've found out the guilty point. Personally, I would rather make a new circuit (this actually happened to me, you know).
2. Solder knows that rather than connecting ground and V_{cc} (though it is potentially more dangerous for your IC's), it can make your life even worse by connecting some other adjacent points. So you have to do connectivity checks all over your PCB. But even worse, there can be stray resistances by a little flux (Soldering flux is applied along with the solder metal while soldering, to increase the fluidity of the solder.) or a thin strand of something. In this case, you need to keep measuring the resistance and to compare with expected values for large deviations.
3. So much for soldering problems. There might be cases when the output of a chip (like a timer or microcontroller) is too 'feeble' to generate some response, like lighting up 10 LEDs. In this case, you should use some sort of an amplification device. It may be a BJT (for novices: this is a transistor), an op-amp, a MOSFET, or an IC.

4. The analog multiplexers (like 4053) are vicious, inveterate traitors. They have the habit of not getting pulled down to zero – the problem of floating values. The solution is to arrange for a pull down yourself, through a 220ohm (or maybe 500ohm) resistor. And NEVER ground the pull down directly. Doing so would have disastrous temporal, psychological, mental, and monetary consequences.
5. While giving a PWM to your motor drivers, you'll have an easier life if you use a PWM of relatively lower frequency. Don't use all the 8MHz your AtMega 16 has to give. The switching action of motor drivers is much better at lower frequencies.
6. The Sercon Mini programmer might *sometimes* give unsatisfactory results. This usually happens when you've not pulled down the RESET pin of your microcontroller. It's always advisable to do so. A symptom is that despite an impeccable code, your bot has gone absolutely nuts. (Note that the impeccability of the code is best decided by somebody other than who has coded it)
7. Now I come to the part that many people underestimate – the code itself. Oh yes, it's just programming. But making an actual code work isn't very easy. Let me give you an example. I coded my robot to count lines, and to turn left when it registered count=3,7 and 13. After it counted 3, it kept moving in a circle. What had happened was that after counting 3, I had coded it to move, and so it did. It never incremented the count – it was always 3, and hence the running around in circles. To solve that I coded it to do a count++ after every (timed) turn. Moral of the story is, that, after coding, think like a machine and follow the instructions given in your code. Usually, the coder isn't able to find out the fault without giving the bot a practical run. That's usually the time, most problems crop up.
8. Realise that the microcontroller is a very dumb thing. It has no sense of purpose at all. It will do *exactly* what you ask it to, not what you want it to. For example, I coded my microcontroller to register a count, every time three sensors of mine were on a white patch. Now, what happens is that, the microcontroller, works on a clock pulse

basis and registers counts for ALL clock pulses as long as the sensors are on the line, resulting in an increment of a few thousand. Solution – use interrupts at falling edges, or (to make things less complicated things) bring in time delays.

9. Always use IC bases on your soldering boards. If you solder your ICs directly, they might get damaged due to the heat. Also, you can always replace them, if they've blown up or gone faulty.
10. If you don't want to slow down or stopping your robot in a competition, make sure before starting, that your power sources are reliable and your batteries are fully charged.
11. While writing complicated and long codes, make sure that there isn't a lot of nesting. The microcontroller has to remember the previous loop in which it was, and the number of loops it can remember is very small. And as a corollary, recursion is a big no-no.
12. For those of you who use interrupts, make sure that you know the priority order of interrupts. Remember that a lower priority interrupt isn't called when a higher order interrupt is working.
13. Occam's Razor is very apt in robotics, that is, the simplest solution is the best. Remember that you are dealing with limited space microcontrollers. Therefore, do not make your code unbelievably complex and long.

Finally, I assume that the reader will not commit asinine blunders like misreading datasheets and wrongly connecting pins. If you do, may Atmella, the Goddess of circuits, help you! *Happy Robotizing !*

Acknowledgements

I am thankful to the Co-ordinators of the Robotics Club and senior IIT Kanpur Robocon team members. Robocon is an international robotics competition held by the Asian Broadcasting Union (ABU). The first National Robocon Contest was organized by Centre for Mechatronics at IIT Kanpur in 2002. Visit www.roboconindia.com for more details.

Pratyush Pandey (prpandey@iitk.ac.in) is a second year undergraduate student in the department of Electrical Engineering. He is interested in Electronics (especially Embedded Design), Robotics and Quantum Computation.

Concepts of Physics

An interview with Dr. H.C. Verma

Mohit Kumar Jolly and Deepesh Raj

Dr. H.C. Verma needs no introduction. The idol for all JEE aspirants, the favorite of all students who have ever attended his PHY102 or PHY103 class, the godfather of all kids from various underdeveloped localities close to IIT Kanpur, the pedagogical Guru and a great social engineer. NERD team got the pleasure of talking to him about various facets of his personality. Here are some of the excerpts of his interview with us:

NERD: Sir, you have been in this institute for almost two decades. What trend have you witnessed in technical and research activities over the time and students' involvement in them?

Dr. Verma: The technical activities have gone up very significantly. When I was a student here, the only such activity I saw was through the Physics Society- talks by professors and paper reading contests. Now, students are getting more involved in research activities as SURGE and going out for summer training at various research centers and universities all across the world.

NERD: Your book 'Concepts of Physics' is nationally reputed and respected as the Bible of Physics. What was your motivation and inspiration for authoring that book?



Dr. Verma: (Laughs) I started teaching Physics at the reputed Patna Science College in 1979. I was asked to teach B.Sc and M.Sc students as well as those in standards 11 and 12. I was a big fan of the book by Resnick and Halliday, but I

was unable to motivate students of standards 11 and 12 for understanding physics by teaching with that book. It was indeed a shock for me. Over the years, I realized that I enjoyed that book because I studied it in my M.Sc., when I was mature enough to appreciate its beauty. I looked for other physics books for my students but could not find one containing the same implicit beauty of physics. Finally, I decided to give a try at authoring one such book. I took 8 years to complete it.

NERD: You have been taking various initiatives for innovative physics teaching at school level by devising many simple demonstration experiments for students. Can you please elaborate on your favorite experiment?

Dr. Verma: (Smiles) I have devised around 150 simple experiments and have an emotional attachment with all of them, but the one that has clicked the teachers the most is the 'Dettol Bottle Experiment'. It demonstrates the internal reflection of light from a water surface in a dettol bottle.

We take a dettol bottle, fill it partly with water and make it turbid by adding dettol or soap. Then a laser beam is introduced through the sides, which gets internally reflected by the water surface. Due to turbidity, the path traced by the beam is clearly visible and the internal reflection of light can be easily seen.

Invariably, all the teachers who have seen this experiment have given it a loud applause, and they have told me that the reaction was similar when they performed this in their class in schools.

NERD: 'Bal Vigyan Mela' has been a great success and appreciated throughout. What were the difficulties you faced in organizing it and what did you learn from it?

Dr. Verma: It was a gigantic task, but was managed well. The administration was very helpful. A team of 40 odd people was made to look after the academic part. 664 students participated in it. Most of them were from classes 6, 7 and 8 of low-key schools from Nankari or Barasirohi. 120 experiments were demonstrated and then the final Mela had 8000 visitors. It was a beautiful experiment in education, where we demonstrated that science can be taught without the use of blackboard, equations, text books and homework, since we used none of them in this six-week long program.

All training was through interesting experiments followed by discussions. 36 themes were identified, including air pressure, thermal conductivity, torque, mirrors and lenses, buoyancy, acid base detection and what not. Each theme had 3-4 experiments. After this 6-week training, everybody knew as much science as any high school student would know.

On the final day of Mela on November 18, 2007, the confidence and enthusiasm with which the children were demonstrating the experiments, explaining the science and answering the questions to the audience was simply great. They hardly cared whether the person they are teaching is a faculty at IIT Kanpur. They were the real icons of the day.

NERD: You have been the spearhead of social transformation through 'Shiksha Sopan'. Are you in favour of introducing social engineering as a course for students so that the society as a whole can benefit from science?

Dr. Verma: 'Jeevan Vidya' group is trying something similar. They did it in some colleges in Madhya Pradesh. They are in a better position to answer such questions. I go more for the field work.

NERD: It has been felt that the very instinct for gaining knowledge gets drastically low among students once they clear JEE. Do you think that efforts like Anveshika can regain their interest in science?

Dr. Verma: The roots for this problem lie in the school education, which is unable to set a nice

goal for the students. I receive mails from students of class 11 and 12 that the goal of their life is to crack JEE. These are all false targets. Once the goal is achieved, they have nothing to do. The education in science has

“Target of cracking JEE is a false target.”

such a beautiful path to follow, but science is taught in history fashion in schools. The bigger joy of discovering nature is not experienced and put forth.

Anveshika is essentially an open ended laboratory where uncommon experiments are set up without constraints of any board syllabus or examination. New experiments are continuously evolved as and when any idea strikes the students or the teachers. Students in classes 9, 10 and 11 need to work in such areas.



Dr. H. C. Verma

NERD: What do you feel has been the most important contribution by you to the scientific community in terms of your research area?

Dr. Verma: Science is a very vast subject and I really enjoy it. Even a small piece of discovery by me gives me immense pleasure and I feel myself to be a part of the great scientific community all across.

NERD: Your home page states that the present education system in the country lacks the basic elements of practical knowledge, ethical and virtuous values. What pedagogical techniques or improvements would you suggest at IIT Kanpur?

Dr. Verma: Well, as you see, it is too late for students as they are already forged by 15 years of school education. Yet, we can try. When I take the first year B.Tech course on physics, I perform small experiments in class to correlate theory with practical, and tell them stories about the interrelation of different aspects of education. Just pumping in information is not the pedagogy to be followed with IIT Kanpur students.

They probably need no professor for it. But we give them too much of information and no education. The music masters teach one 'Raga' to their disciples and rest is left to their creativity. Such pedagogy needs to be implemented here too.

NERD: IIT Kanpur is one of the best technical institutions of India, and yet we have no such central repository where technical publications by students and faculty over the years are at least listed. Don't you find this to be a very strange situation?

Dr. Verma: It is a very good observation made by you and I hope your endeavor NERD solves it.

NERD: No platform exists in IIT Kanpur where people working on various research areas can write for the general audience. NERD is such an initiative. What plans would you suggest to sustain it?

Dr. Verma: NERD is an attractive idea. There are two aspects involved with people active in research- their own personal careers and the satisfaction of being heard by a larger audience. If they are provided an opportunity with not much time constraint, they will contribute to NERD and this would be beneficial for the campus community in general. I would personally love to contribute as much, and with 300 faculty members in IIT-K, you need not worry about its sustainability.

NERD: What do you think was the vision of setting IIT Kanpur? How far we have realized it in half a century?

Dr. Verma: IITs were set up to develop a technological base which can drive India into a global competition. Yes, IIT Kanpur is an international brand name now. I have seen a significant contribution of students recently in managing the show, despite the fact that they come after 15 years of forging.

NERD: You have been the apple of every eye throughout the country. What are your plans after retiring as a faculty?

Dr. Verma: (Smiles) Wherever I will be, I will be serving science and education. I will put a Teacher Resource Center where teachers of various subjects from schools and colleges can interact and learn to enjoy the subject they are

teaching. During an IIP (Introductory Interaction Program) in Agra, I interacted with a group of teachers just for 6 hours, emphasizing the need for experiment based classroom teaching and demonstrating around 25 experiments at various levels (class 6 to class 12). Two of the teachers came to me after the workshop and told that they were proud of the profession they were in. The education system is not controlled by the government or the HRD ministry, but the first authority to spoil a child is teacher. Teachers have to be

“The first authority to spoil a child is the teacher.”

made realized that they are in a noble profession and shoulder a great responsibility. This has been my part time effort and I will dedicate myself completely to it soon.

NERD: Describe Dr. H.C. Verma in one line.

Dr. Verma: (Thinks) I have experienced that science is very enjoyable. I try to integrate myself with education, science and society at large.

NERD: What is your final message to the students?

Dr. Verma: My message is that there is much more to explore in nature. Don't focus just on the course content. If you can appreciate the implicit beauty of science and engineering, it will be great.

NERD: Thank you Sir! It was a great pleasure talking to you.

Dr. Verma: Most welcome!

Mohit Kumar Jolly (mkjolly@iitk.ac.in) is a third year undergraduate student in the Department of Biological Sciences and Bioengineering. He is interested in Biomechanics and Biomedical Engineering.

Deepesh Raj (draj@iitk.ac.in) is a sophomore from Computer Science and Engineering Department. He is interested in Java and C++ structured programming, image processing and animation development.

Dhwani: Let's Echo!

Notes on programming in Indian Languages

Veerender Kumar

Introduction

A man X from 1995 talks to Y, a man from 2015.

X from 1995: Hey man! Why are you writing an article for Telugu newspaper in English?

Y from 2015: Chill man! My software will convert it into Telugu.

Y converts a part of the text into Telugu. X could not digest it at all and disappears.

Just think- a computer runs on 0 and 1 and has nothing to do with any human language. Right! Then why is it not possible to write a program in any language? It can be and it is. A program can be written in any language and in any script; only we have to do is to develop a parser and a code generator for that language which converts any human language into machine language automatically.

How and when was 'Dhwani' first heard?

Dhwani is a group which has taken initiatives to explore the possibilities of developing the code generator. It started with an exhibition on 14th September, 07, named *Dhwani*, where Brahmic scripts extending from central Asia to Japan were displayed along with their origin and their historical and geographical transitions. It gave everybody a chance to know why India was the center of knowledge and prosperity in ancient world and how these things spread across the world. Witnessing the response, a lecture under *TaLeS* was organized on November 7, 2007. We were recommended to form a group for continuous and collective effort. Thus *Dhwani* was born.

Recent Developments

The next breakthrough was a workshop on computational linguistics in Hyderabad Central University (HCU) and its collaboration with *Dhwani*. FOSS (Free and Open Source) India awards 2008 winner Abhishek Chowdhary addressed *Dhwani* on February 24. He mentored the project named *Hindawi*, which

provides equivalent compilers for C, C++, Java, FORTRAN, BASIC, Lex, YACC in most of the north Indian languages. His team has also developed a better transliteration scheme known as 'Romanagri'. It also contains its own development environment, i.e. real-life software can be developed from Hindawi. (Visit www.hindawi.in for further details.) He proposed the concept of software exchanges in small towns where software contracts will be available on bidding. Dhwani along with Simmortel Voice (a SIDBI startup which is developing a platform for speech recognition-based local search and downloads) organized a workshop in Computer Center (CC) on Automatic Speech Recognition on February 12, 2008. More than 190 students registered in it.

Dr. Laxmidhar Behera (Department of Electrical Engineering) is an expert on artificial intelligence and embedded systems, and he is working on Sanskrit, its advantages in NLP (Natural Language Processing) and artificial intelligence. Pawan Goyal, a PhD scholar at IIT Kanpur, is developing a Sanskrit English Translator. His two research papers are selected for 2nd Symposium on Computational Linguistics of Sanskrit, USA. In summer 2008, *Dhwani* developed a keyboard friendly to Indian languages and Hindi version of LOGO, the computer language which is taught to children. *Dhwani* is also working on designing Indian Phonetic Alphabet.

Let us be heard all over!!

Dhwani group envisions making India the IT superpower by 2020. With 6% computer penetration, we have become an IT soft power. With 20% or more penetration, we can certainly become an IT superpower!

Veerender Kumar (veek@iitk.ac.in) is a second year undergraduate student in Department of Economics. His research interests include political economy and feminism. He is currently working on possibilities of structural and ethical changes in India.

ATLAS SHRUGGED: Gluco-Band

A much cheaper and easier treatment of Diabetes

Vikram Pagaria, Rohitesh Gupta and Parag Surana

Ever noticed carefully a mosquito silently sucking your blood and injecting its saliva into the host? Mosquito's proboscis, which is about 2mm long and 30 μ m in diameter, is capable of penetrating into the skin and drawing blood thereafter. We do not feel pain because micro dimensions of the proboscis are too small for our pain receptors to feel their presence.



The Anopheles mosquito

Here is a device named 'Gluco-Band' that involves an integrated approach combining blood glucose measurement, analysis and controlled insulin delivery in a single device, using the same concept of mosquito bite. It is a novel semi invasive integrated device for efficient home management of diabetes, only at Rs. 2000 per year.



The Motivation

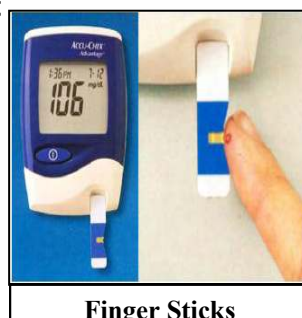
Diabetes mellitus is a chronic metabolic disorder caused by defects in insulin secretion, which causes hyperglycemia (high blood glucose). Visual impairment (leading to blindness), kidney damage, doubled risk rate of heart diseases, foot ulceration, nerve damage and slow healing of wounds are some of its prolonged effects. It is one of the major causes of premature death worldwide. *India has the highest prevalence of diabetes in the world (32 million expected to increase to 78 million by 2030 according to WHO estimate), while only 10% of Indians receive appropriate treatment for the same.* As India has no subsidized, coordinated diabetes care programme, reducing treatment costs through raising public awareness, regular monitoring and earlier diagnosis should be a key objective.

Diabetes requires efficient management for treatment. *A number of lifestyle changes are necessary* such as modification of dietary practices, weight management, physical exercise, monitoring of body fluids (blood, urine) and

periodic tests, foot care, adherence to medication schedules, *thereby lowering the QOL (Quality of Life) of diabetic patients throughout.* Devices which could painlessly and accurately measure blood glucose levels and deliver insulin appropriately are highly sought after. Cheap and user friendly home management solutions which automatically works day in and day out are preferred as they provide freedom to users to lead normal lifestyles. *There is a need for a device which is as discreet and integrated as the human pancreas itself.*

Current techniques in use

The current methods to deliver insulin in patient's body with minimal pain and invasion include insulin syringes, insulin pumps and inhalers.



Finger Sticks

Regular monitoring of blood glucose and proper monitoring of insulin dosage is required to avoid hypo and hyperglycemia. But, multiple daily injections of insulin, frequent monitoring of blood glucose and adherence to stringent dietary practices coupled with the necessity of coordinating food intake and insulin administration is difficult, especially for adolescents. No wonder most patients do

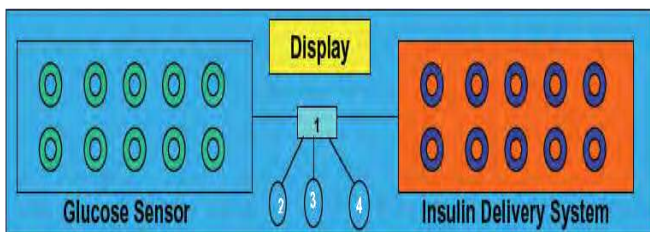
not use the tools and do not follow strict regimens of intensive treatment necessary to achieve tight glucose control. High costs of these meters also play a role in limiting their popularity among patients, where as their accuracy is a common topic of clinical concern too. Major concerns in current insulin methods are regarding non invasiveness and controlled delivery. These devices are clumsy and proper maintenance is necessary. This results in slower approval of the device by the users.



Insulin Pump

The Idea

We call our device as '*Gluco-Band*', a band which can be worn on the shoulder. The band will have a glucose sensing medium, an insulin delivery system (incorporated with insulin reservoir) and micro-controllers to couple the detector with the delivery system. The glucose sensor as well as the insulin delivery system will be available as separate patches and could be replaced mutually exclusive of each other. The patch is a conglomeration of different mosaics (containing the micro needle sensing/delivery system). This band will look like:



In the figure above, (1) represents the blood level glucose display (with numeric key guard) to take input from the user/clinician. (2) is the on-off switch. Pressing this switch will start the glucose sensing. (3) and (4) are two alarms for intimating the user. (3) intimates the user to refill the insulin reservoir, while (4) tells the user to replace the patch.

Contemporary BioMEMS (Micro-Electro-Mechanical Systems) features support the idea and increase its level of feasibility.

Salient Features

The salient features of this device are:

1. *Wearable device*– point of care treatment
2. *Painless automated device*– Improved user compliance
3. *Cost effective*

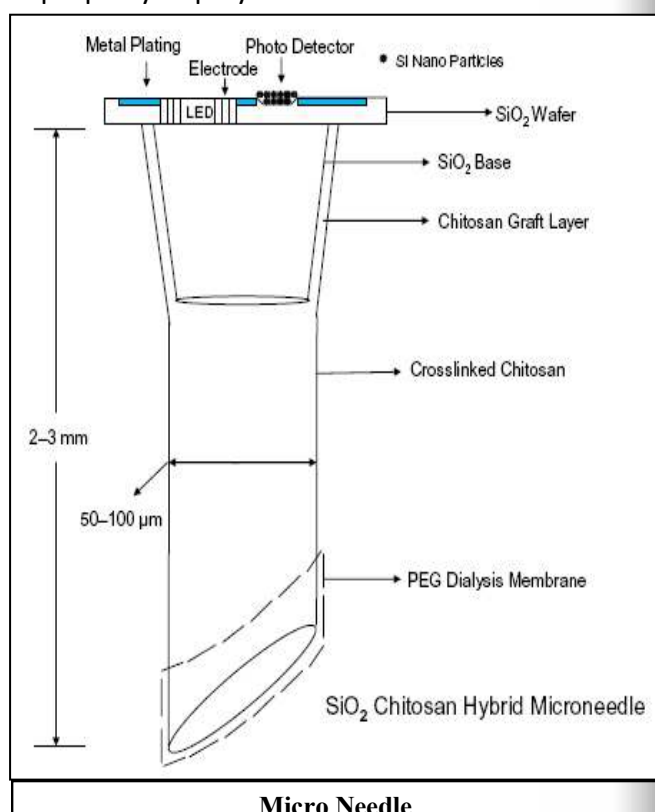
Device Design

The device integrates many components. The critical components to be assembled are:-

1. Micro needle Fabrication
2. Glucose Sensor
3. Insulin Delivery System

Micro needle Fabrication: The basic design for micro needles to be used in glucose measurement and insulin delivery is very similar. Its shape at the bottom will be funnel-like to provide minimal contact (bruising) at the surface and provide sharpness. Polymer investment molding in combination with silicon wafer etching is proposed to be used for their fabrication.

Brittleness is a major problem in repeated use of long micro needles. Needles must be able to tolerate forces associated with insertion, intact removal and normal human movements. A hybrid micro needle as *chitosan coated silicon needle* would bring in the advantages of strength of silicon and stress absorption property of polymers.



Needles need to be sterilized every week. They are not meant for long time use because of their certain failure rate. The whole patch must be replaced every 3-6 months (depending on the usage).

Glucose Sensor: The closed loop approach of coupling glucose measurement and insulin delivery can be designed efficiently using fluorescence based technique. Its advantages are high sensitivity, absence of electrochemical interference *in vivo*, and the potential (with near infrared light) for non-invasive monitoring. The *glucose-galactose binding protein (GBP)* from bacteria *E.coli* has served as glucose detector in several fluorescence based sensors. To improve the glucose detection assay, another micro needle will be immobilized with GBP protein.

In the present proposed biosensor, dextran/concavalin A (Con A) competitive binding system will be used for measuring glucose present in interstitial fluid. This system will be immobilized on the inner surface of chitosan micro needle. The free amino group present on the chitosan will be well exploited to covalently link fluorescent molecules to its surface. *Poly ethylene glycol (PEG)* has been selected over various biocompatible polymers because of having the least influence on immune system thereby reducing the chances of inflammation on the material-fluid interface, and being stable under various psychological conditions.

The sensing instrument will have a photonic analyzer exposing the biosensor to excitation produced by a Light Emitting Diode (LED) that is directed through the battery. The light falls on the dextran molecules and excites them. The intensity of light emitted by dextran molecules will be detected by silicon nanoparticles functioning as a photo detector,

which quantifies the captured photons and correspondingly conducts electricity to the micro-controller and LED display.

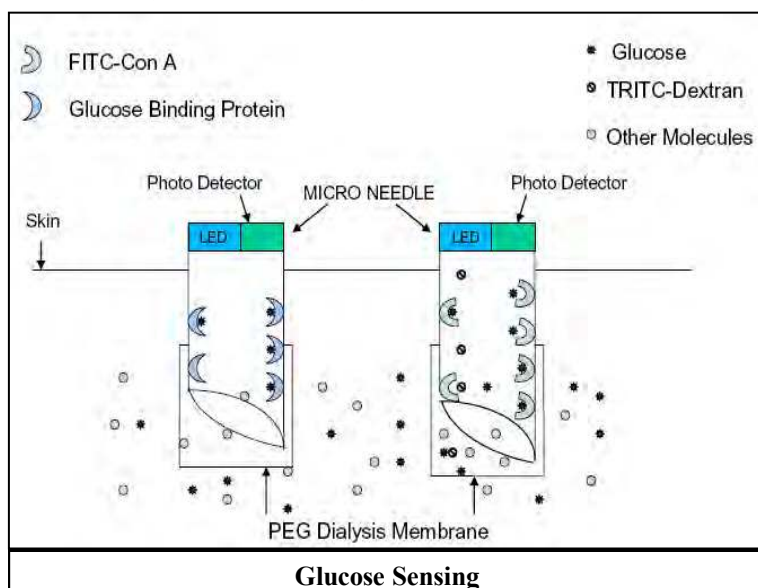
Insulin delivery: The amount of insulin needed to be delivered will depend on the deviation from the normal blood glucose levels as well as the patient's Insulin Sensitivity Factor- the drop in blood glucose level; measured in mg/dl caused by each unit of insulin taken. *The normal blood glucose level in the body is 70-110 mg/dl*, however it can increase to 100-140 mg/dl just after the meal or when metabolic activities are few.

We propose to integrate the glucose reading with a microprocessor which will calculate the deviation of the measured glucose level. A user-interface in our device in which the *Insulin Sensitivity Factor* can be input (preferably by a clinician) depending upon the severity of the disease, also needs to be incorporated. (Insulin

Sensitivity Factor = $1500 / \text{Total daily dose of insulin}$). We also propose rechargeable insulin cartridges cum reservoirs as well as an alarm system in the device to convey the message to the user to install the new reservoir in place of the finished/ almost finished reservoir (The reservoir has ≤ 5 units of insulin). We

can easily manufacture insulin reservoirs of different preparations (rapid-acting, short-acting, intermediate acting, long acting) and the user can choose from different preparations depending on his routine activities (lifestyle) and the severity of the disease.

Based on the input value of the Insulin Sensitivity Factor and the blood glucose level, the microcontroller will calculate the amount of insulin to be delivered and communicate this to the insulin reservoir. The insulin reservoir will pump the corresponding amount of insulin only to the patch which has already perfused into the skin and not to others.



As safety constraints, we need to keep in mind that no single dose is more than 4 units of insulin and the total dose delivered in a time period must not exceed 25 units of insulin. Moreover, the insulin dose must be less than or equal to the capacity of the insulin reservoir.

Feasibility of the idea

No commercial device is available which integrates glucose sensing with insulin delivery. Fortunately, most of the components needed for manufacturing the 'Gluco-Band' are available or can be fabricated from contemporary well-established MEMS techniques. Microcontrollers, alarm systems and batteries needed are widely available. Since we are working at the MEMS level, the quantities of enzymes, drugs or other molecules needed are significantly decreased and hence the cost further comes down. In addition, micro fabrication techniques are very cheap if fabrication is done on a large scale. The companies which manufacture micro needles are Kumetrix and DeBioTech.

Cost Analysis and Diabetes Market

DEVICE COMPONENTS COST p.a.(INR)

Micro needle fabrication	<500/-
Glucose sensor	5/-
Battery	20/-
Microcontroller	10/-
Band Design & Assembly	400/-
Total cost	<1000/-
Taxes (@12.5%) ~	125/-
Patch replacement (maximum) depends on usage and severity	1200/-

Total cost of using the device= 2500/- p.a.
(The total cost excludes insulin cost).

The global market of diabetes (2005) was around 18.6 billion U.S. Dollars. It has been estimated by the World Health Organization that about 230 million people are affected with diabetes worldwide. It is expected to increase to 350 million by the year 2025. As a consequence of increasing urbanization and associated lifestyle changes, this increase will be greatest in the developing world. By 2025, over 75% of diabetes cases will be in the developing world.

Summary

We are developing a novel semi invasive integrated device for efficient home management of diabetes. The device targets both Type 1 and Type 2 patients worldwide and especially India, who are looking for economic treatment. The wearable device uses fluorescent molecules to subcutaneously measure blood glucose without drawing any blood. This information is processed and directs painless micro needles, modeled on mosquito, to subcutaneously deliver insulin. The cost effectiveness, pain free and integrated functions of the device will encourage patients to adopt and implement proper glycemic control, necessary factor for higher quality of life. Our device Gluco Band provides huge benefits in costs and will result in higher margins as well as higher sales.

Acknowledgements

We are thankful to Dr. Shubhayu Basu (Stanford alumnus, bioentrepreneur), Dr. Manoj Varma (Ex-CEO, Quadruple Technologies), Dr. Ashutosh Sharma, Dr. Shantanu Bhattacharya, Dr. Anupam Pal and Dr. Alope Dutta (Faculty, IITK) for their useful advice and constant motivation.

Accolades

This idea was presented in Bio-Business Plan (BBP) in Techkriti'08, the annual science and technology festival of IIT Kanpur. It secured third prize worth Rs. 10,000.

Turning ideas into reality

Recently, the research on designing the device has started in IIT Kanpur by a group named 'Power-U', under the supervision of Dr. Ashutosh Sharma. Interested students are invited to join to make this idea turn into reality.

Vikram Pagaria (vikrampg@gmail.com), Rohitesh Gupta (rohitesh.gupta@gmail.com) and Parag Surana (paragsurana@gmail.com) are alumni of IIT Kanpur of Class of 2008 from the Department of Biological Sciences and Bioengineering. Vikram is now working with Irunway in Bangalore. Besides being excellent at academics, he dedicated his four years at IIT Kanpur for social service. He also served as the coordinator of Prayas Club. Rohitesh is presently working in Dr.Reddy's laboratories at Hyderabad now. He has been the coordinator of Photography Club at IIT Kanpur for an year. Parag is now pursuing Ph.D. from NCBS Bangalore.

Science behind the Tragedies

Harshal Agarwal (Source: Internet)

Bhopal Gas Tragedy, also known as 'Hiroshima of the Chemical Industry', is India's biggest industrial disaster. In the early morning hours of December 3, 1984; Union Carbide company's pesticide producing plant leaked a highly toxic cloud of methyl isocyanate (MIC or CH_3NC), which killed 8000 people and injured over 3 lakhs. Many of the survivors suffered for a long time from one or several of the following ailments: partial or complete blindness, gastrointestinal disorders, impaired immune systems, post traumatic stress disorders, and menstrual problems in women.

Union Carbide India Limited (UCIL) was licensed to produce the insecticide carbaryl. MIC, an extremely reactive compound, was used in its manufacture. The scientific reason for the accident was the leakage of water into the tank E610 containing 43 tons of MIC, resulting in a sudden explosion. This exothermic reaction caused the temperature to rise above 200 degree Celsius while the optimum temperature the tank could hold was about 75-80 degree Celsius. The safety valve of the tank burst because of the increase in pressure in the tank, leading to instantaneous blast.

The released toxic gas cloud contained HCN, CO, HCl and phosgene. The gas, being denser than the air, stayed close to the ground. The

weak wind and the weak vertical turbulence caused a slow dilution of gas and thus allowed the poisonous gas to spread over considerable distances. The initial effects of gas exposure were coughing, vomiting, severe eye irritation and a feeling of suffocation. No one got any chance of escape and the very next day, thousands of dead bodies were lying on the streets. The majority of deaths and serious injuries were related to pulmonary edema-swelling in lungs, leading to respiratory failure.

Several questions have been raised about the irresponsible behavior of the company. The refrigeration system designed to ensure the MIC volatilization was idle for a long period and coolants as freons were being removed, to cut the cost measures. The absence of slip blind isolation plates caused H_2O to mix with MIC. The location of the plant in the densely populated area was itself a catastrophe. The MIC's tank alarms were not working for 4 years, and the MIC tank itself was malfunctioning for a week.

All these reasons built up to this disastrous tragedy, the black day in industrial history of India and the world as a whole.

Harshal Agarwal (harshal@iitk.ac.in) is a sophomore undergraduate student from the department of Computer Science and Engineering. He is interested in computer architecture and assembly language.

Rail Hand Car

Can the simple mechanism of a see-saw be the motivation for a project which bagged the *BEST Project award in TA201N* (Introduction to Manufacturing Processes) in 2007-08 Semester II? Yes. It is indeed -the model for a Rail Hand Car, which is widely used for railway inspection and maintenance and can be put on and off the rails at any place easily due to its low weight,

was designed efficiently by UG sophomores. Rail Hand Cars are used for mining operations and to run passenger services on minor railway lines in many countries.

Sheet metal forming was used to manufacture two fly discs, two chairs and a large shade. The four wheels of the car and the bigger gear were casted and then shaped on lathe too.

After cutting teeth in the spur gears in ratio 3:1 by milling, holes (of various sizes) were drilled in fly discs, cranks, shafts, supporting plates, gears, angles and the assembling of parts was completed using welding and brazing. The group members told that by the use of one ratchet in opposite direction and ensuring the full rotation of the crank shaft on the fly disc, the car can be moved in both directions.

It was a great learning experience for them. Hope you all come up with even better projects in your turn!

Team Members: Akanshu Govil, Alok Pratap Singh, Amit Vikram Singh and Amit Kumar.



Rail Hand Car

Stepping Stones

Faez Ahmed, a sophomore from Mechanical Engineering Department, pursued his summer internship in *Universiti Sains Malaysia (USM), Malaysia* with the USM Robotics Research Group. He worked there mainly on the design of an underwater pole inspection robot and tunnel inspection robot. The underwater pole inspection robot was for the inspection of oil rig poles, which often corrode or crack and the divers face difficulty in going to a depth of 100 metres due to the gigantic pressure there. The tunnel inspection robot was to detect the corrosion and cracks inside the culverts (drains/channels crossing under a road). It faced problems of slipping and water proofing. We asked him what things got him so absorbed in robotics in his *first year itself*.



Faez Ahmed

In his first year, he attended all the lectures of Robotics Club and BRICS. He started preparing for Technokratics (the intra IIT-K Robotics Competition) but failed in his line follower robot. Fortune favours the brave, and so did it favour him. He finally made his first robot from lego kit- it was used to remove obstacles from the way. He continued participating in the events organized by Robotics/BRICS/Electronics Club. He utilized his time in winters and worked on a wall climbing robot using PDMS adhesive with Dr. Ghatak. It succeeded

to climb up to 65 degrees but due to lack of time, the project was postponed.

Then came Techkriti'08 for which he had been preparing for 2 months. He made two robots:

1. *Battle of Atlantic*- It was a simple boat type robot which collected TT balls and threw them in basketball type goalpost.
2. *Saviour Sense*- It was a semi autonomous robot used to detect varying voltage and then press the switch if detected.

He had to develop and destroy many models for these robots and burnt the midnight oil till the final designs were ready. He got the '*Best Design Award*' for Saviour Sense and both of the robots managed to the finals.

He was also selected for a summer internship at Middlesex University, London for aerial and ground robotics. The 5 shortlisted students were asked to submit videos demonstrating their work. His video was selected, but insufficient financial support did not permit him to go and learn there.

So, wonders can be created in short time, provided you decide that you have to create them.

Faez can be contacted at faez@iitk.ac.in or faez.iitk@gmail.com.

It Happened Here: Bio-inspired Patterned Adhesives

Abhijit Majumder

How many times the same piece of an adhesive tape, commonly known as 'cellotape' can be pasted and taken out? Once, twice may be thrice, but not more than that. After that, the tape loses its adhesive strength. Now, let us look at the adhesive pads of insects and animals like grasshoppers, house lizards or tree frogs. How many times they use the adhesive pads placed at their feet? Probably, hundreds of millions of times in their lifetime! And that too without any specific maintenance and any serious adhesive failure!! Not only reusability but the natural adhesive pads come with a complete package of strength, reusability, self-cleaning and easy de-bonding during movement. None of the man made adhesives has such remarkable qualities, be it our daily used tape or acrylic based adhesive. Once used, they deform permanently, get contaminated with dust and other particles and lose their adhesive efficiency. The reason is that the conventional adhesives are made of a gummy "viscoelastic" material. When one tries to separate two objects pasted with viscoelastic adhesive, much of the pulling energy gets dissipated in the surrounding adhesive in deforming it, away from the actual separation point. This dissipation of energy makes the adhesive stronger, but sacrifices clean separation and reusability. Once deformed, they never come back to their original shape. On the other hand, the natural adhesive pads, instead of viscoelastic dissipation, rely on van der Waals force which makes them reusable, strong, self-cleaning and attachable to any kind of surface irrespective of its roughness (or smoothness)

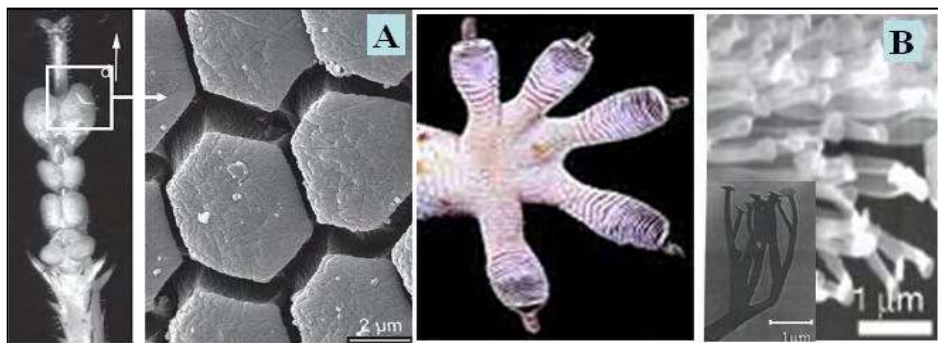


Figure 1. Micro to nano scale surface structures found at the adhesive pads of bush cricket (fig a) and gecko (fig b) are found to be responsible for their adhesive strength, reusability and self-cleaning property.

and surface properties. All these amazing qualities which nature has developed by millions of years of experimentations seem possible to achieve only by taking a leaf out of nature's own book.

To do so, we need to understand first how these dry natural adhesives work. Years of scientific research has shown that these adhesive pads have micro to nano-structures at the surface which are complex and highly hierarchical with large structures dividing into smaller ones that finally end as fine hairs with a cup (Figure 1A and B). These fine hairs called "setae" (figure 1B) have the minimum dimension of few hundred nano-meters and they number in billions per mm square of the adhesive pad. This slender structure and large number allow them to easily follow the roughness of a surface closely and to come in intimate contact which is essential to employ van der Waals force of interaction effectively. As a result, these adhesive can attach to rough and smooth surfaces alike, can detach easily and can undergo many thousand cycles of adhesion and debonding during their life time. Because of their elastic character, these adhesives are free from particulate contamination and permanent deformation that makes man-made adhesives non-reusable.



Other than bringing the adhesive into intimate contact with the adhering surface, these patterns play another important role that is called crack arrest and crack initiation. Recent experiments on model polymeric adhesives with surface patterns show that when a flexible adherent is peeled off the adhesive layer, the surface crack does not propagate smoothly as against on a smooth adhesive surface; the crack propagates intermittently by stick slip kind of motion. Figure 2 depicts this experiment in which an incision patterned adhesive film remains strongly bonded to a substrate and a flexible plate is detached at a controlled rate while the detachment load is measured. The surface crack gets arrested when it meets the sharp edge of a discontinuity because of the effect of crack blunting and additional energy is required to drive it. The video micrographs 2a-e show this sequence of events prior to the crack initiation at f. Once initiated, it propagates catastrophically till it meets the next discontinuity where it gets arrested again. By optimizing the length-scale of these discontinuities the adhesion strength can be increased by an order of magnitude.

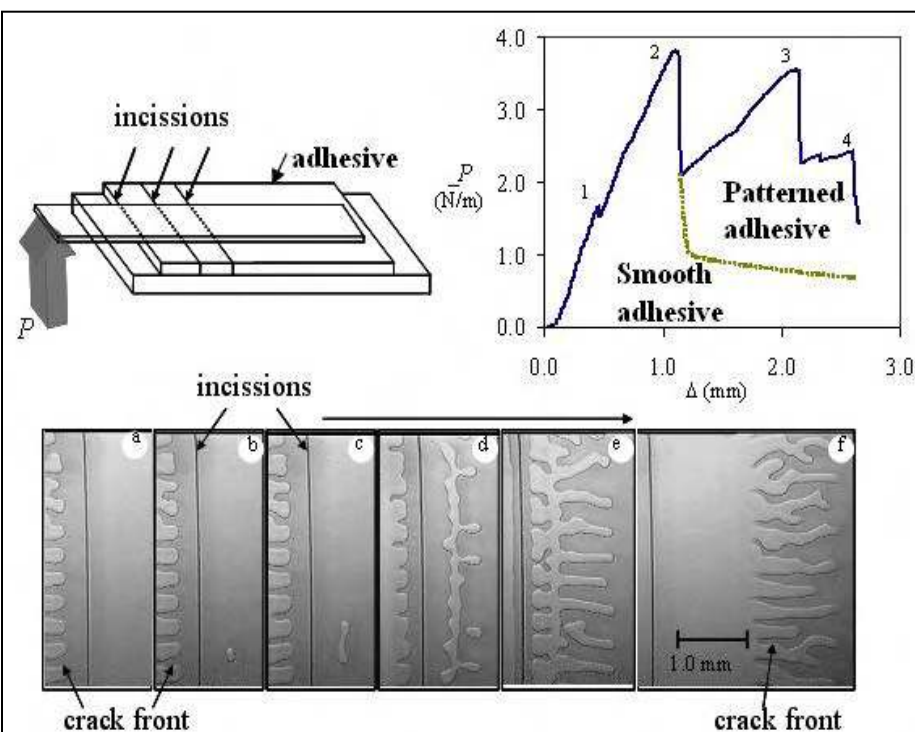


Figure 2. Peeling experiment with patterned surface shows crack arrest effect resulting in enhanced adhesion. The wavy line in the video micrographs shown in figure a-f is the crack front and the arrow at the top of the figure shows direction of crack movement (known as crack propagation). When the crack front approaches an incision, it gets arrested there and higher force is required to be applied to propagate it further. This effect is shown in the graph (force-displacement plot) where force required to propagate a crack on a patterned adhesive is compared with that on a smooth adhesive. Each peak in this plot represent effect of an incision where the crack gets arrested.

However, other than these surface patterns, the natural dry adhesive pads have subsurface structures too. Figure 3a shows the adhesive pad of the insect *Rhodinus Prolixus*. In this picture, one can clearly observe the presence of large fluid-filled sac. Figure 3b shows the bush cricket and the internal structure found at its adhesive pad. In this figure also, one can see two big air sacs embedded into lots of viscoelastic fluid called haemolymph. The presence of this subsurface fluid carrying structure has been known to the scientists and entomologists for long. However, their role in adhesion mechanism has never got attention and been studied.

Inspired by this observation, we made elastic adhesive films embedded with subsurface micro-channels (Figure 4A). The detailed method of making these microchannels can be found in our earlier work (Verma et al, Langmuir, 2006). We then brought a flexible microscope coverslip into complete contact with this adhesive and then peeled this coverslip off by lifting it vertically from its hanging edge at a constant rate, as shown in Fig. 4B (known as displacement controlled peel

test). The peeling force, F was recorded using a load cell interfaced with computer via a data acquisition card. We have already seen that the internal structures of the insect adhesive pads are filled with air or some other viscoelastic liquids. To mimic the same, we also studied the effect of the channels when filled with air and when filled with liquids of different viscosities. The results will be described in succeeding sections.

Peel test on adhesives layers with embedded micro-channels filled with air:

The peel test on an adhesive film with embedded micro-channels filled with air show that on such a film, the crack

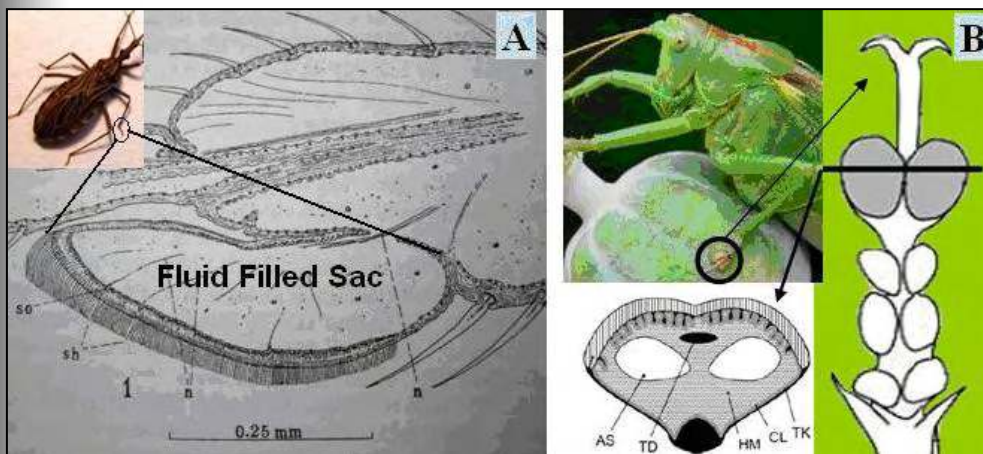


Figure 3. Sub-surface structures filled with different fluids can be found in insect adhesive pads. Figure 2A and 2B shows the examples of sub-surface structure found in the adhesive pads of insect *Rhodnius Prolixus* and *Tettigonia viridissima* (bush cricket) respectively. In fig 2B, AS: Air sack, CL: Epidermal cell layer HM: Haemolymph, TD: Tendon of the claw flexor muscle, TK: Tanned cuticle

edge of the film, the subsequent ones appear because of the embedded micro-channels. The figure shows that each microchannel causes a considerable increase in peeling torque resulting enhanced adhesion. This increase in adhesion energy is due to dissipation caused by a discontinuity in the bulk. To initiate a crack, one needs to strain the

material until it reaches a critical stress level. After that, when the crack propagates over the smooth surface, this critical stress level is maintained at the crack tip and for an elastic adhesive, no further supply of strain energy is required. However, a discontinuity in the form of incision (figure 2) or in the form of channel (figure 4) can disrupt this mechanism. In that situation stored strain energy can not get transferred from one side of the discontinuity to the other. As a result, the crack gets

propagates with intermittent arrests and initiations at the location of channels, similar to situation described in figure 2. This stick-slip behavior is reflected in the plot of the peeling torque M against displacement Δ of the flexible plate in figure 4C. Here, $M=F \cdot a$, where F is the applied force (refer figure 4B) and ' a ' is the distance between the point of application of F and the crack front. The plot shows existence of several peaks. While the first one corresponds to the initiation of crack at the

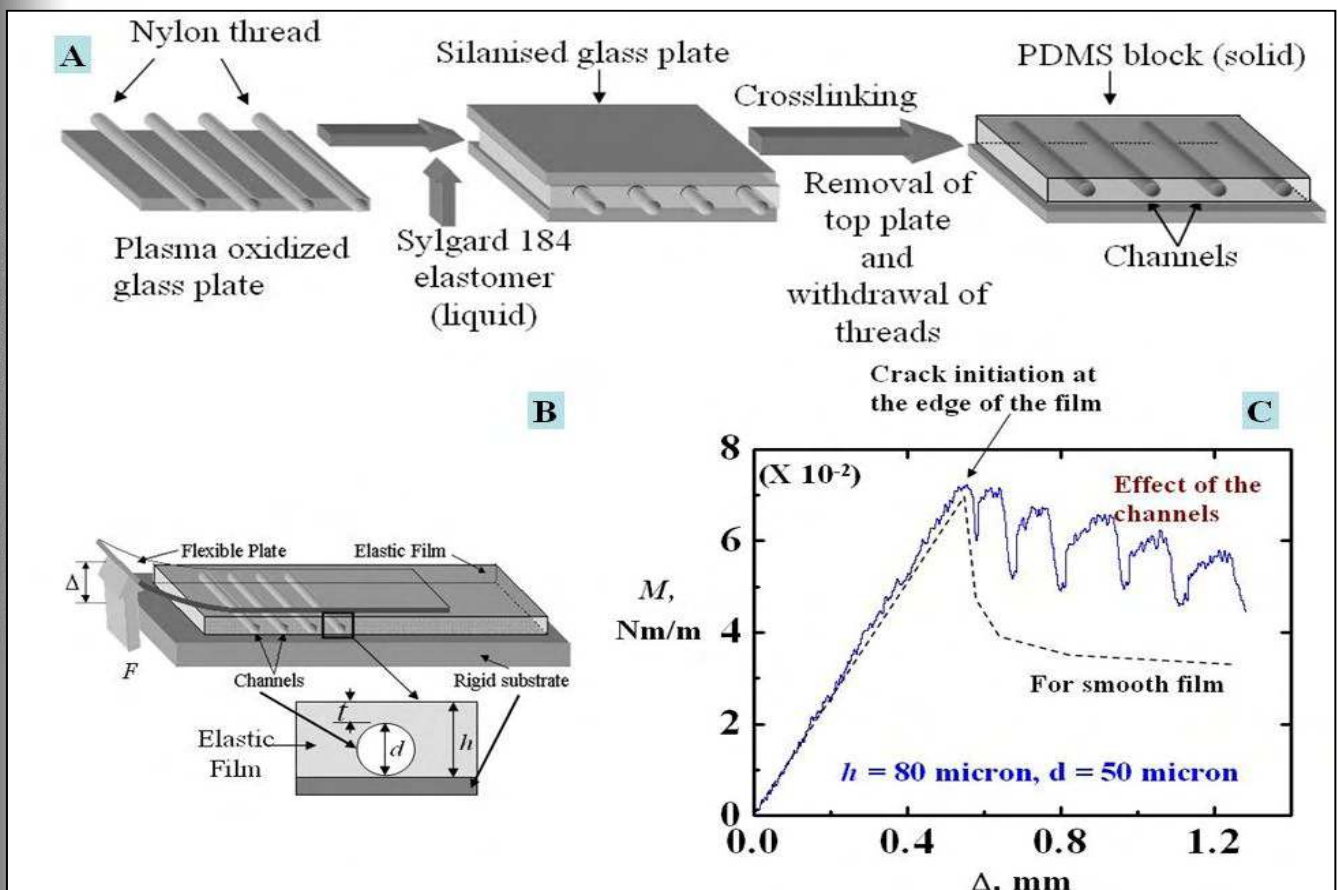


Figure 4. A. Template assisted 3D micropatterning technique (Langmuir 2006). B. Experimental scheme: Displacement controlled peeling of a flexible microscope cover slip off an elastic adhesive film with embedded micro-channels. C. Presence of microchannels deter crack propagation and thus increases the torque required to peel a cover slip off an adhesive film.

arrested at the vicinity of the discontinuity and further supply of energy is required to re-initiate the crack. This suggests that the energy dissipation at a channel should be proportional to the void fraction α caused by that channel. Indeed, the fractional increase in fracture energy derived from various experiments with different channel diameter, film thickness and rigidity of the adhering plate, was found to vary linearly with void fraction α .

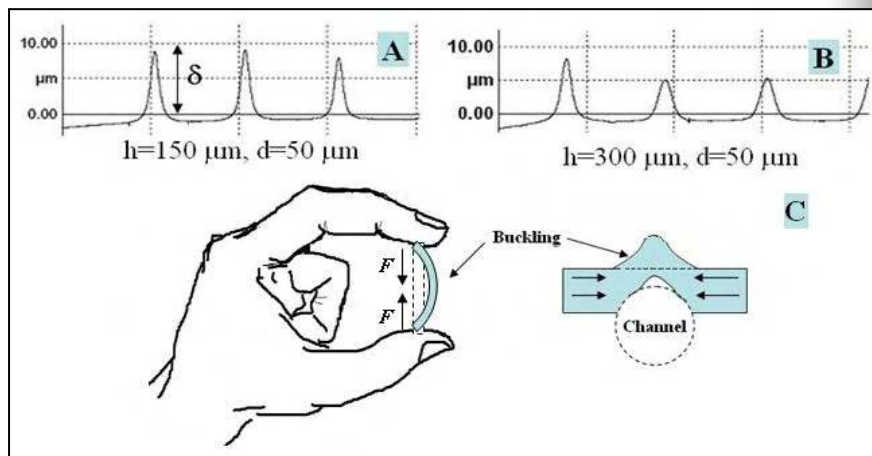


Figure 5. Optical profilometry shows surface buckling caused by negative capillary pressure inside the channel. Each channel leads to each of the peaks. A. For thinner films the deformation bulges appear as “spikes” with narrow peaks. B. for thicker films, the deformation flattens out. C. Pressing a slender elastic material from two ends causes buckling.

Peel experiments on adhesive layers with embedded micro-channels filled with viscous liquid:

The adhesion effect of the films with embedded channels increases further when we fill the channels with liquids of appropriate surface tension and viscosity. We filled the channels with silicone oils of viscosity 5-50,000cP and surface tension 22 mJ/m². Although these oils fill in the channels by capillary action, they do not diffuse into the network of PDMS in the timescale of the experiment (~ 10 min.). However, it creates a negative capillary pressure inside the channel and also in close vicinity of its elastic wall. So pressure at this location goes down. Away from it, pressure in the film remains atmospheric. As a result, the thin skin layer on top of the channel gets pressed from both the sides and buckles up (Figure 5A and 5B), similar to the buckling of a visiting card when you hold it by your index finger and thumb and then press it (Fig 5C). For thinner films the

deformation bulges appear as “spikes” with narrow peaks, which do not allow the plate to come in complete contact with the film. However, as the film thickness increases, the deformation flattens out resulting in a complete contact with the contactor.

Peeling test on these films gives typical plots $M-\Delta$ as presented in Fig. 6A. Curve 2 ($h=300\mu\text{m}$, $d=50\mu\text{m}$) in this plot shows when the channels are filled with oil of viscosity 380 cP the crack gets arrested at the vicinity of the channels and a large torque is required to re-initiate it. However, for a smooth film (curve 0) or when the same channels are filled with air, no such effect is visible (Curve 1). This type of stick-slip propagation becomes more prominent for higher diameter channel (curve 3: ($h=750\mu\text{m}$, $d=710\mu\text{m}$)). The effect of oil can also be seen (Fig 6B) in terms of fracture energy G which increases to about 1600mJ/m² when these channels are filled with an oil of intermediate

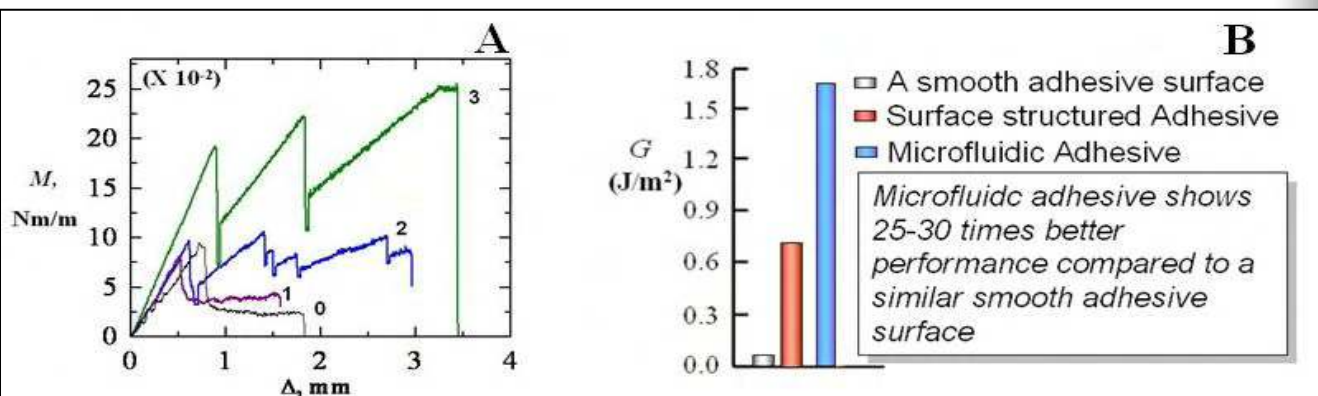


Figure 6. A. The peeling torque M vs. Δ . Curve 0 corresponds to a smooth film of thickness $h=300\mu\text{m}$. Curve 1 and 2 represent film of $h=300\mu\text{m}$ and $d=50\mu\text{m}$ for channels filled with air and oil of viscosity $\eta=380\text{cP}$ respectively. Curve 2 clearly shows higher peeling torque over curve 1. Curve 3 correspond to $\eta=380\text{cP}$, $h=750\mu\text{m}$, and $d=710\mu\text{m}$ which requires even higher peeling torque leading to high fracture energy. B. Microfluidic adhesive shows higher adhesive strength compared to an otherwise similar smooth adhesive surface.

viscosity. This remarkable enhancement in G by about a factor of 25, compared to otherwise similar but smooth adhesives, is achieved without incorporating any viscoelasticity in the adhesive but by simply manipulating the pressure inside the subsurface channels. As a result, the adhesive as a whole does not lose its adhering quality on repeated peeling. Interestingly, the same elastic layer can be used both as a strong adhesive and an easy release coating. To achieve that we embedded two layers of channel ($d=50\text{m}$) within the adhesive at two different vertical locations ($t_1=120\text{m}$ and $t_2=300\text{m}$). When the channels of the top layer are filled with oil while those at the bottom layer contain air at atmospheric pressure, the deformations at the surface of the film is too large to allow the plate to come in contact with the film. The adhesive then behaves like an easy release coating with effective adhesive energy to be zero. However, if the channels at the bottom layer are filled with oil instead of those at the top, the peel experiment yields the $M-\Delta$ plot with characteristic peaks at the location of the channels. This result shows that the same film can be used as a strong adhesive and a release coating without altering the intrinsic rheological or surface properties of the film.

This significant increase in adhesion energy can be explained in terms of critical stress that is to be maintained at the crack tip for crack propagation. As mentioned earlier, to initiate a crack, a critical tensile stress has to be reached. Once initiated, this stress level is maintained at the crack tip. However, when the crack meets a channel filled with oil, negative capillary pressure inside the channel frustrates the tensile stress. As a result effective stress at the crack tip goes down. To maintain the critical stress which is essential for crack propagation, further increase in applied external load is required which manifests itself in terms of enhanced adhesive strength.

Conclusions

In contrast to the known mechanisms of enhancing adhesion, e.g surface patterning, hairy structures, and chemical modifications, we have presented a mechanism for enhancing and modulating adhesion by embedded subsurface liquid-filled microchannels in an

adhesive layer. A spatial segregation of the elastic and viscous domains allows for a clean and reusable separation of the elastic surface, unlike the conventional viscoelastic adhesives. The confined liquid in the microchannels exerts compressive stress on the flexible wall, which causes the formation of bumps on the film surface. These can either diminish or enhance the required energy during separation. This mechanism suggests strategies for the design of more efficient and cleaner pressure sensitive adhesives. The possible application of such a kind of tunable elastic adhesive is as wide as imagination. Starting from using in a sticker which will not leave any dirty residue to automotive industry to different biomedical applications and finally to a pair of gloves which can convert you into the Spiderman, a strong reusable glue-free clean adhesive can find its way everywhere.

Acknowledgements

The profilometry study has been done in Advanced Ceramic Lab at IIT Kanpur. Help and assistance received from Dr. B. Basu of Advanced Ceramic Lab and his students are gratefully acknowledged.

Ponder Yonder

1. M. Scherge and S. N. Gorb, *Biological micro - and nanotribology: nature's solutions*, 2001. Springer, Heidelberg, Germany.
2. K. Autumn *et al.* *Proc. Natl Acad. Sci.* 2002, 99, pp 12252-12256.
3. A. Ghatak *et al.*, *Proc. R. Soc. London, Ser. A*, 2004, 460, pp 2725-2735.
4. A. J. Crosby *et al.*, *Langmuir*, 2005 21, pp 11738-11743.
5. N. J. Glassmaker *et al.*, *Proc. Natl Acad. Sci.* 2007, 104, pp 10786-10791.
6. A. K. Geim *et al.* *Nature Materials*, 2003 2 pp 461-463
7. J. Y. Chung and M. K. Chaudhury, *J. R. Soc. Interface* 2005 2, pp 55-61.
8. M. K. S. Verma *et al.*, *Langmuir*, 2006 22, pp 10291-10295.
9. A. Majumder *et al.*, *Science*, 2007 318, pp 258-261.

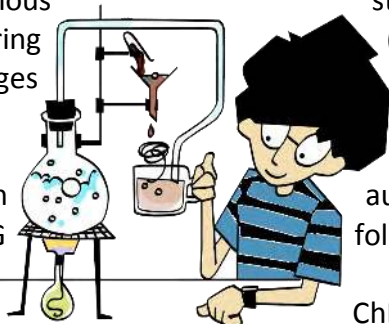
Abhijit Majumder (majumder@iitk.ac.in) is a doctoral student in Department of Chemical Engineering working with Dr. Animangsu Ghatak (aghatk@iik.ac.in). His research interests include adhesion, adhesives and mechanics of soft matters.

ChEmference 2008

ChEmference 2008 was a national level conference organized by postgraduate students of Chemical Engineering at IIT Kanpur on July 5 and 6, 2008 aiming at motivating and bringing together the research scholars to discuss and share their ideas and innovative solutions to some problems plaguing the society. ChEmference 2008 was inaugurated by Dr. Kripa Shankar, Deputy Director, IIT Kanpur. It was a platform for the young ones who have just leaped into research to get exposed to the various facets of Chemical Engineering and meet the challenges encountered.

ChEmference evolved as an intra-IIT K conference of PG students of Chemical Engineering Department in 2003. It followed the same format till 2006, but ChEmference'07 could not be organized. In 2008, the students planned to make ChEmference'08 a national level event. *Being completely organized by students*, it was a huge success with special lectures delivered by experts all around the country.

Broadly classified into four sessions consisting of all major fields in Chemical Engineering, it left no stone unturned. Talks by students from IIT Kanpur as well as 6 other institutes were given on topics such as nanotechnology, process control and operation, complex fluid flow, environmental engineering, optimization techniques, drug design and what not. *There were total 20 oral presentations and 8 poster presentations.*



Keynote address was delivered by *Dr. Vijay M. Naik* (IIT Bombay) on the patterns of creativity in development of science and technology. Special talks were given by Dr. Narendra M. Dixit (IISc Bangalore) towards optimizing the treatment of HIV infection, Dr. K.S. Gandhi (IISc Bangalore) on development of electro-chemical power systems, Dr. G.D. Yadav (UIC Mumbai) on changing face of chemical engineering in a dynamic world, Dr. S. Narsimhan (IIT Madras) on exploiting process structure in optimization and Dr. Pradip (TRDDC, Pune) on demands of modern chemical engineering. The panel discussion on Industry- Academia relationship was appreciated by a huge audience. A cultural program by a Rajasthani folk group was also conducted.

ChEmference'08 was a mega success. Its vision to develop into an annual cyclic meet of research scholars where concentration, reaction, germination and diffusion of research ideas could take place was beautifully realized.

Mr. Chandra Shekhar Sharma, a doctoral student in Chemical Engineering Department at IIT Kanpur was the Convener of ChEmference'08. He can be reached at cssharma@iitk.ac.in.



ChEmference 2008

The Casimir Effect: A Force From 'Nothing'

What will happen if you place two uncharged plates facing each other?

Parul Singh and Avirishu Verma (Source: Internet)

Most probably you would say: "What is there to wonder about? Obviously nothing as they are uncharged." Well, the answer is not at all that OBVIOUS. Surprisingly enough, the plates will attract each other (Amazing, isn't it?). The scientific world calls this the Casimir Effect, after Dutch physicist Hendrick Casimir, who first predicted this startling phenomenon while working on the properties of colloidal solutions at Philips Research Laboratories in 1948.

Casimir effect is (yet) another phenomenon where the quantum effects seem to contradict our classical intuition. This seemingly weird effect is measurable only at smallest distances from the plates (typically few nanometres). At separations of 10 nm - about a hundred times the typical size of an atom - the Casimir effect produces the equivalent of 1 atmosphere of pressure. Although the magnitude of the force is small, Casimir force is the strongest force between two neutral objects at distances less than a micrometre. This attractive force has a purely quantum origin since it is a direct consequence of the quantum field theory which says that there is no 'perfect vacuum'. Even in (seemingly) empty space or vacuum, fluctuating electromagnetic waves of all possible wavelengths are present and are normally invisible to us. In other words, there is turmoil of virtual particles that come in and out of existence very rapidly and their energy is related to their wavelengths (higher energy means smaller wavelengths). For calculating the vacuum energy, only those electromagnetic waves are taken into consideration whose wavelengths are a whole no. of times the gap between the two uncharged plates or mirrors. As this gap is narrowed, the no. of waves contributing to the energy calculation decreases and the energy density between the plates fall below the

energy density of the surrounding space. It causes a 'radiation pressure' on the plates, which on average is greater outside the plates than between them. This results in a tiny force of attraction between the plates, which arises from nothing (recall that these are virtual particles!).

$$F \sim A/d^4$$

where F = the Casimir force, A = the cross section of the plates, d = the gap between them.

Another fascinating aspect is that if one computes the energy density between the plates, it turns out to be negative! As you (hopefully) know, there is nothing in the universe with negative energy density. (Zero energy density is the energy density of normal 'empty space'.) The obvious question then is how does that system couple to gravity? Is this really a negative contribution to the total mass? Does it get repelled by the earth?

Although our daily life experiences do not include such small distances, they are important in nanoscale structures and MicroElectroMechanical systems (MEMS)-micron-sized devices in which mechanical elements, tiny sensors and actuators are integrated into a common silicon substrate.

Ponder Yonder

If you are interested to learn more about Casimir effect, you may visit:

<http://www.casimir.rl.ac.uk/>

<http://backreaction.blogspot.com/2007/11/casimir-effect.html>

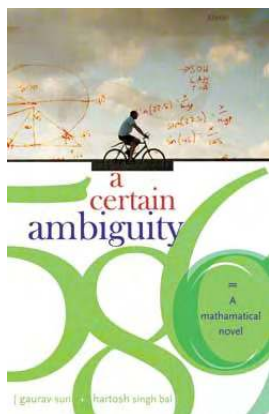
Parul Singh is a sophomore from Aerospace Engineering Department and interested in physics and programming.

Avirishu Verma is a sophomore from Computer Science and Engineering Department and interested in multimedia, webpage designing and animation.

DOG-EARED

A Certain Ambiguity

Arvind Kothari



NERD Rating: 4.5/5

Published by: Penguin Books India

Published: October 2007

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Price: **Rs 450.00**

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ISBN13: 9780670081363

Edition: Hardback

Pages: 292 pp

Genre: Fiction

SAC Book Club Availability: Available (1 Copy)

Awards: Winner of the 2007 **Award for Best Professional/Scholarly Book in Mathematics**, Association of American Publishers

Review

It's a mathematics book, it's a novel, it's a mathematical novel! Yes, you read it right! *A certain ambiguity*, is a mathematical novel, a genre not unheard of but certainly rare and special in its own way. Even thinking of using Mathematics as the basic premise of a novel is daring feat and the authors Gaurav Suri and Hartosh Singh Bal have pulled it off efficiently here. *The book will be an enjoyable read not just for mathematicians but for anyone who is intrigued even slightly by mathematics and has just a basic knowledge thereof. Simple high school math will do!*

The book starts with the Pythagorean Theorem and moves through beautiful and interesting demonstrations of Basic Number Theory, Set Theory, Euclidean Geometry, Non-Euclidean Geometry and Infinite Series with an ever so slight tinge of Relativity. Intertwined with the math is a discourse on the nature of truth and the struggles between faith and reason.

The narrative follows the story of Ravi Kapoor, an Indian Graduate student in Stanford

University in the late 1980s, and his mathematician grandfather Vijay Sahni who tried to pass on his passion for mathematics to Ravi. He dies leaving aside money for sending his grandson to graduate school in America.

Ravi meets Nico Aliprantis, a Mathematics professor in his 60s, through a friend and decides to sign up for his class on "Thinking about Infinity." During the course of these classes Ravi discovers that he is confronting the same mathematical and philosophical dilemmas that his grandfather had faced many years earlier. He discovers that these same dilemmas had landed his Grandfather in jail when he was in America, charged under an obscure blasphemy law in a small New Jersey town in 1919.



Ravi unearths documents and transcripts related to his grandfather's case and conversations with a judge who was appointed to examine the merits of the case thereby reliving what his grandfather experienced while in jail. As the novel proceeds we find the protagonist, his grandfather and the judge struggling with the question of whether there can ever be absolute certainty in mathematics or life. Their outlooks and fundamental beliefs undergo transformation with their parallel explorations in the study of geometry and infinity. Finally the novel concludes on the grounds that although absolute certainty may be outside our reach but we can still make sense of the world and knowledge around us. It's just that sometimes a leap of faith might be required.

The characterization is warm and simple yet compelling and entirely believable. The plot is interesting and conclusion is open to interpretations providing enough food for

thought. The fictional diary entries of great Mathematical minds throughout history make the reading even more interesting. The conversations of Vijay and the Judge are thought-provoking although they do become dragged out some places. The brief treatment of mathematical epistemology towards the end of the book is enlightening although the book itself seems to lean heavily on Platonic school of mathematical thought. The notes and short bibliography appended at the end add a sense of completeness to the book.

But there are certain minor mistakes and some issues that should be stated. Apart from a few misplaced diagram labels and inconsistent mathematical notation (in the Set Theory demonstrations), everything is fine with the math. It's a bit odd for a Professor of Nico's rank to say that Galileo invented the Telescope which is incorrect. Also, it is hard to believe that any mathematician like the one portrayed by the jailed Vijay Sahni would be unaware of the existence of consistent theories of non-Euclidean Geometry in a period that was teeming with applications of such theories in theoretical Physics.

These issues apart, *A certain ambiguity* is an amazing, intelligent book with brilliant mathematical insights and anybody with the slightest interest in Mathematics should read this book. It might rekindle the interest of those whose math might be a bit rusty. It

certainly did that to this reviewer. And as Eli Maor, the author of 'e: the Story of a Number' and 'The Pythagorean Theorem: A 4,000-Year History' puts it in his own endorsement of the book, *be warned: once you start reading, you won't be able to put it aside until finished!*

About the authors (from the book's backflap)

Gaurav Suri is a partner at a global management consulting firm in San Francisco and holds a master's degree in mathematics from Stanford. *Hartosh Singh Bal* is a leading independent journalist in New Delhi and holds a master's degree in mathematics from New York University. Suri and Bal have been friends since childhood. This is their first book. A friend of the authors remarked in a review that it is a book *that could not have existed without the Internet - as the two authors live on separate continents. This book was conceived and written as a genuine collaboration using email and regular bouts of instant messaging.* (Italics original)

You can read Gaurav Suri's blog 'The Philosophical Implications of Mathematics' at <http://meaningofmath.blogspot.com/>.

Arvind Kothari (arvikot@iitk.ac.in) is a BTech-MTech Dual degree student in the Department of Mechanical Engineering. He served as the fortieth President of Students' Gymkhana during 2007-08. His interests are publicizing student research, planning for initiative implementation, techno-entrepreneurship and alumni networking.

Zonked!

1. The Number Game

This problem is simple, how would you find the last digit of the integer part of a^{2000} , where $a = 3+7^{0.5}$? (Based on a problem from Google CodeJam)

2. How many Roads?

In the state of Roadland (sorry for the terribly unimaginative name), there are 42 major cities. Some of these cities are connected by roads, where each road connects exactly two cities, and there is at the most one road between any two cities. Inhabitants of Roadland also try to remove obvious superfluity from their road network: so if any three cities A, B and C are such that there is a road from A to B, and one from B to C, then there would not be any road from A to C. How many roads can there be in Roadland? (Based on a well known but simple graph theoretical result)

Questions by Piyush Srivastava (piyush@iitk.ac.in)

Send in your answers at nerd@iitk.ac.in. The entry with both correct answers will be awarded. Awards worth Rs. 1000 to be won!! Submit your answers latest by September 30, 2008.

Cancer Diagnosis

Optical Biopsy for Cancer Detection

Prashant Shukla, Arunabha Ghosh, Dharitri Rath and Binay Bhushan

Biomedical optics involves the fusion of optics (photonics) with biology and medical science. The use of photonics, particularly for optical diagnostics, as well as for light-activated and light guided therapy, has a major impact on health care. It offers great hope for the early detection of diseases and for new therapeutic modalities. The need for novel materials and technologies to detect diseases at early stages, to provide more effective targeted therapies and to restore impaired biological function is constantly increasing. Among the life-threatening diseases, cancer has been one of the deadliest. It can develop in almost all parts of the human body. Some common types of cancer are bladder, breast, colon & rectal, endometrial, kidney, leukemia, lung, melanoma, pancreatic, prostate, skin, thyroid etc. The highest occurrence in males is lungs and liver cancer while in females, it is breast and cervical cancer. The early detection and subsequent prevention of cancer have been a challenging task for researchers all over the world. Some of the conventional techniques used for the diagnosis of cancer are mammography, ultrasonography, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and histopathology. However, each of these techniques has certain limitations of being slow, invasive or expensive. In order to overcome these limitations, researchers have been looking for optical techniques which can be noninvasive (or minimally invasive) and cost effective as well. In recent years, spectroscopy and imaging are being developed as powerful techniques for the early and quick diagnosis of cancer. Fluorescence, Raman and elastic scattering spectroscopy are being used as spectroscopic tools while imaging techniques such as Optical Coherence Tomography (OCT), polarization-gated, time-gated imaging techniques are being developed. With

biological samples, imaging can be done by using either scattered light or fluorescence light. Confocal microscopy imaging, two photon microscopy imaging et cetera are the techniques in which fluorescence is used. On the other hand, polarization gated imaging, Optical Coherence Tomography (OCT), time gated imaging, Mueller imaging etc. are the techniques in which scattered light is used. Our Research in Biomedical Optics and Spectroscopy Laboratory focuses on the use of some of these tools for cancer diagnosis and is briefly described here.



(1) Fluorescence spectroscopy

Fluorescence spectroscopy is an important optical diagnostic technique for early and non-invasive diagnosis of disease due to its sensitivity. Most of the biological systems display a native fluorescence from the various proteins, enzymes etc. present in them. The autofluorescence from human tissues encompasses mainly the UV-Visible regimes with emission from enzymes such as NADH, flavins; amino acids such as tryptophan, tyrosin and the structural proteins, collagen and elastin. The idea behind using fluorescence spectroscopy as a diagnostic tool for tumor detection lies in the fact that tumors induce metabolic changes which are reflected in the emission from proteins, enzymes et cetera. These changes are captured through fluorescence spectroscopy. However, a major difficulty encountered in using autofluorescence from tissue for cancer diagnosis is the fact that in a turbid and multiply scattering medium like tissue, the intensity and line shape of intrinsic fluorescence from the tissue fluorophores get strongly modulated by the wavelength dependent absorption and scattering properties of tissue. This not only masks the valuable biochemical information contained in

the intrinsic fluorescence, but also leads to degradation of intrinsic fluorescence contrast between cancerous and normal tissue sites. Extraction of intrinsic fluorescence by removing these distorting effects of absorption and scattering properties of tissue would thus facilitate a quantitative evaluation of the biochemical basis of the disease and may also lead to improved tissue diagnosis. We have developed two different approaches to accomplish this objective: Polarized fluorescence spectroscopy and spatially resolved fluorescence spectroscopy which are briefly described below.

(1a) Polarized Fluorescence Spectroscopy

The first approach is based on concomitant measurement of polarized fluorescence and polarized elastic scattering spectra from tissue. The polarized fluorescence normalized by the polarized elastic scattering spectra (in the wavelength range of fluorescence emission) was found to be free from the wavelength dependent modulation of absorption and scattering properties of the medium. The underlying principle of this approach is that when excited with linearly polarized light, the polarized fraction of the detected fluorescence records fluorescence from within a few transport scattering lengths of tissue and thus is only weakly modulated by the absorption and scattering properties of tissue.



Fig. 2. Experimental set-up for spatially resolved fluorescence spectroscopic studies.

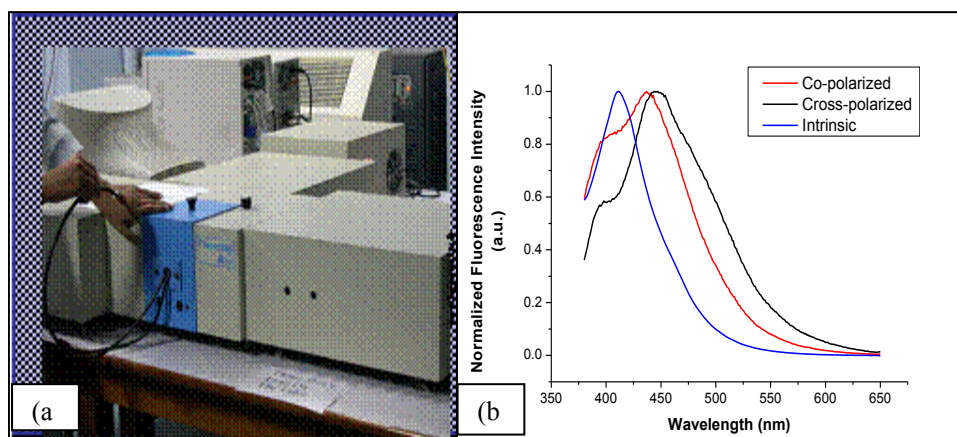


Fig. (1). (a) A photograph of the spectrofluorimeter used to conduct the polarized fluorescence spectroscopic studies. (b) Typical co-polarized, cross-polarized and intrinsic peak normalized fluorescence spectra for normal cervix tissue.

Further, the propagation losses of the polarized fluorescence photons due to absorption and scattering at the excitation and the emission wavelength are similar to the propagation losses of the polarized elastically scattered photons at the same wavelength. The normalization of polarized fluorescence by the polarized elastic scattering thus serves as a means to compensate for the propagation losses and to recover the intrinsic intensity and line shape of fluorescence in a turbid medium like tissue. Since, polarized fluorescence records fluorescence signature from the superficial layer of tissue, this technique may turn out to be particularly suitable for early detection of epithelial cancer. Since this follows for epithelial cancer, the pre-cancerous changes are known to originate within the superficial epithelial layer only. Figure (1) shows the co-polarized, cross-polarized and intrinsic peak normalized fluorescence spectra for normal cervix tissue recorded in our lab. In Figure (1b), one can see that the absorption dip due to blood seen in co-polarized and cross-polarized spectra is removed in the intrinsic spectrum.

(1b) Spatially Resolved Fluorescence Spectroscopy

The second approach that has been developed by us for detection of deeply buried tumors, makes use of spatially resolved fluorescence measurement from tissue. The measured spatially resolved fluorescence from tissue is utilized for simultaneous estimation of the wavelength dependent optical transport parameters, namely, the reduced scattering coefficient,



Fig. 3. Experimental set-up for Raman spectroscopic studies.

absorption coefficient, and intrinsic fluorescence spectra from tissue. The approach utilizes a hybrid diffusion theory-Monte Carlo simulation based theoretical treatment for propagation of fluorescence in tissue to estimate these parameters from the measured spatially resolved fluorescence data. It may be noted here that spatially resolved elastically scattering techniques used by other researchers probe only the morphological changes. However, in our technique, while the optical transport parameters bear useful information on morphological and physiological state of tissue, the recovered intrinsic fluorescence contains rich biochemical information on tissue. Simultaneous determination of these parameters under the same geometric conditions and from the same probing volume of tissue might turn out to be advantageous for the development of diagnostic algorithms that could exploit both the morphological and the biochemical information contained in these parameters for optimal tissue diagnosis. In our laboratory, an array of fibers probing a distance of about 5 mm of the sample is being used to collect spatially resolved fluorescence from breast tissue samples excited by Argon ion laser source at a wavelength of 488 nm. Figure (2) shows the fluorescence recorded from the array of fibers along with the spatially resolved fluorescence spectra of two-

layered tissue-mimicking phantoms (rhodamine and flavin adenine dinucleotide (FAD)).

(2) Raman Spectroscopy

Raman Spectroscopy is another optical diagnostic technique which, due to its specificity, may turn out to be a vital tool for early detection of cancer in tissues. This technique offers the possibility of nonintrusive diagnostics both in vitro and in vivo and provides a detailed biochemical composition of the sample. Raman scattering arises from perturbations of the molecule that induce vibrational or rotational transitions. Only a limited number of biological molecules such as flavins, porphyrins, and structural proteins (collagen and elastin) contribute to tissue fluorescence, mostly with overlapping, broadband emission. In contrast, most biological molecules, such as nucleic acids, proteins and lipids are Raman active with fingerprint spectral characteristics. Therefore, Raman spectroscopy provides specific information about the tissue compositions in contrast to fluorescence spectroscopy which is more sensitive technique and gives the presence (concentration) of endogenous fluorophores inside the tissue. Because of this, vibrational spectroscopy may overcome some of the limitations of fluorescence diagnosis of precancers and cancers.

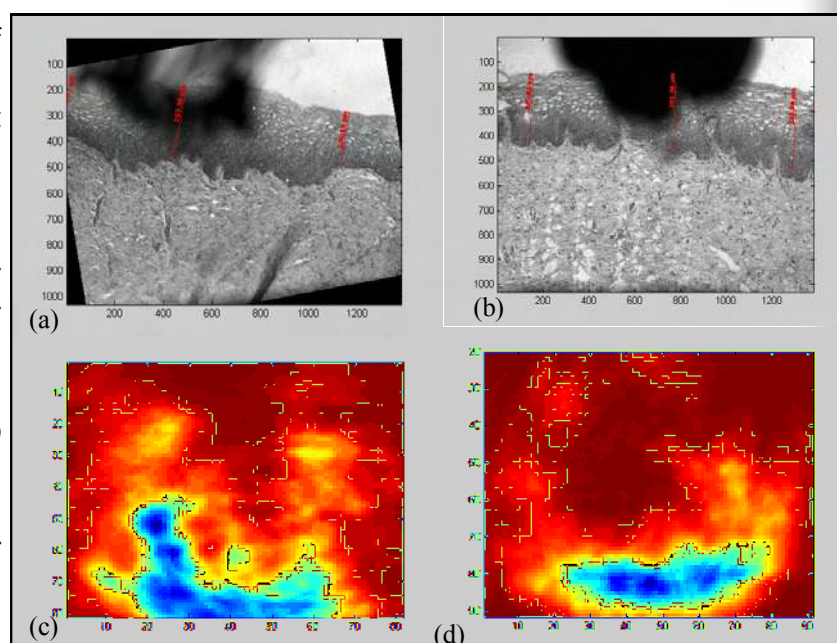


Fig. 4. (a) and (b) are microscopic images of normal and dysplastic state of cervix tissue while (c) and (d) are their corresponding depolarization images obtained by polar decomposition of Mueller Matrix.

Currently, our work in the laboratory aims towards determining fingerprints of early stage of tumors using 785 nm, 500 mW diode laser and a micro-Raman facility to record 'polarized' Raman spectra from pathologically characterized human tissues (cervical, oral and breast). This technique has the potential to provide depth and hence valuable information regarding progression of cancer in tissues which may help in its early detection. Figure (3) shows the experimental set-up being used in our laboratory for Raman spectroscopic studies.

(3) Imaging technique (Polarization Gated Imaging)

Apart from spectroscopy, imaging with light has also emerged as a powerful tool for biomedical applications. The advantage of imaging technique lies in the fact that one can map a larger area of the affected region and probe variation within it in a short time. Our study involves imaging the elastically scattered light from tissue samples to probe the minute morphological changes that occur during the progress of a disease. Our group focuses on polarization gated and Mueller matrix imaging for tissue simulating models and human tissues by exploiting the polarization property of incident light. When a polarized light is incident on a highly scattering medium, it is scattered and there is reduction in polarization power. This loss in the polarization of scattered light reflects the morphological changes in medium. Mueller images for normal and dysplastic or early precancerous state of cervix tissue have revealed interesting changes which correlate well with microscopic tissue images as shown in Fig. (4). Fundamental studies to understand the effect of size and refractive index on polarized light interacting with tissues are also on. This reveals important aspects of diagnostics using circularly and linearly polarized light.

Further studies are in progress to fully exploit the potential advantages of the developed optical techniques towards attaining the desired goal of noninvasive and early detection of cancer. These optical techniques may not substitute for already established techniques such as mammography, ultrasonography, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and the 'gold

standard' histopathology, but can work in tandem with these as complementary techniques for early detection of cancer in human bodies.

Acknowledgements

We would like to acknowledge IIT Kanpur, BRNS and CSIR for providing funds for equipments used in the research. We would also like to put on record the support obtained from our collaborators at GSVM medical College, Kanpur.

Our related publications

1. Wavelet Transform of Breast Tissue Fluorescence Spectra: A Technique for Diagnosis of Tumors, Nidhi Agarwal, Sharad Gupta, Bhawna, Asima Pradhan and K.Vishwanathan, Prasanta K.Panigrahi, IEEE JSTQE, Vol. 9, 154 (2003).
2. Recovery of turbidity free fluorescence from measured fluorescence: An experimental approach, N.C. Biswal, Sharad Gupta, N. Ghosh and A. Pradhan, Optics Express, Vol.11, 3320 (2003).
3. Wavelet based characterization of spectral fluctuations in normal, benign and cancerous human breast tissue, Sharad Gupta, N.C.Biswal, Nidhi Agarwal, Maya S. Nair, Asha Agarwal, P.K.Panigrahi, Asima Pradhan, Journal of Biomedical Optics, Vol.10, p- 054012-1 to 9 (2005).
4. Sharad Gupta, V. L. N Sridhar Raja and Asima Pradhan, "Simultaneous Extraction of Optical Transport Parameters and Intrinsic Fluorescence of Tissue Mimicking Model Media Using Spatially Resolved Fluorescence Technique" Applied Optics, Vol.45, 28 (2006).
5. Prashant Shukla, R.Sumathi, Sharad Gupta, Asima Pradhan, "Influence of size parameter and refractive index of scatterer on polarization gated optical imaging through turbid media", JOSA A, Vol. 24, 1704 (2007).

Ponder Yonder

Visit <<http://www.iitk.ac.in/celt/asima%20web%20page/homepage.htm>> for further details.

Prashant Shukla (shuklap@iitk.ac.in), Arunabha Ghosh (ghosha@iitk.ac.in), Dharitri Rath (dharitri@iitk.ac.in) and Binay Bhushan (bhushan@iitk.ac.in) are working in Biomedical Optics and Spectroscopy Lab with Dr. Asima Pradhan (asima@iitk.ac.in) in the Center for Laser Technology (CELT) under the Department of Physics.

Computing's Very Own Fair Lady

An interview with Frances 'Fran' Allen

Nishith Khantal

Frances Elizabeth 'Fran' Allen is an IBM Fellow Emerita at the T. J. Watson Research Laboratory with a specialty in compilers and program optimization for high performance computers. She was appointed as an *IBM fellow* in 1989, making her the first woman to receive this recognition. She is the recipient of ACM's 2006 *Turing Award*, the first woman scientist in the forty year history of the award. Turing Award is often recognized as the Nobel Prize of Computing. She retired from active service in IBM in 2002 the year when she also won the *Augusta Ada Lovelace Award*. With a smile like that of a grandmother with a thousand fairy tales, her life has been an epitome of and testimony to the *immense potential of women researchers*.



Fran is an active mentor, advocate for technical women in computing, environmentalist, and explorer. She can be reached at allen@watson.ibm.com.

Conversations

This interview was taken during her visit to IIT Kanpur in December 2007 for the **Workshop on Architectures and Compilers for Multithreading** organized by the Department of Computer science and Engineering, IIT Kanpur from 13th to 15th December. She delivered a keynote address titled **Languages and Compilers for Multicore Computing Systems**.

NERD: Tell us about your experience at IIT Kanpur?

Fran Allen: I have been to lot of universities looking at their environment and how the universities work. I think IIT Kanpur has a great environment. It has a wonderful feel. Also lot of peacocks over the campus makes it even better (Laughs). There is a feeling of

collaboration over the campus. IIT Kanpur has really some great work going on.

NERD: Tell us something about your childhood and early years. What were the expectations from you as a girl?

Fran Allen: I was born in 1932 in upstate New York on a family farm among the dairy cows (Laughs). I was the oldest of all six children. As kids, we enjoyed doing farm work. As a girl in those years, it was expected to marry a farmer or become a nurse or become a school teacher. In High School, I had a wonderful Mathematics Teacher, which led to my interest in Mathematics. After my college I took up a job of a school teacher, in the same school I graduated from.

NERD: How did you end up at IBM?

Fran Allen: I was interested in Mathematics especially in Geometry. I went to attend the University of Michigan to get the master's degree. IBM came to the campus. Since I did a course on computing as one of my electives, IBM offered me a job. I was heavily in debt at that time. Since IBM gave a good pay, it was also a chance for me to pay my debts. I decided to join IBM but only till the point I finish paying off my debts.

However, when I joined IBM, I found the field was very young. There was no computer science at that time. It was fun- very exciting and stimulating environment. I enjoyed new challenges and new fields and thus went on continuing with IBM.

NERD: Tell us something about your field.

Fran Allen: When I joined IBM, FORTRAN was just there. The first assignment which I got was to teach FORTRAN to the scientists. I was intrigued by the language. The language

increased the programmer's productivity, and it became much easier to write code. I got very interested in compilers and for the rest of my career, I worked in the field of compilers, their optimization, high performance computers and what not (Laughs).

I also got interested in Parallel Computing. Some seminal work was done at that time in the field. The idea of parallelism surfaced very early. John Nash attempted to define parallelism though his model but could not become very popular. However the interest was revived during the 50s. Accessing data was the biggest problem in making the system fast. Parallelism was identified as one of the solutions to this problem.

It is very hard to come up with a definition for parallel computing. People use several models to describe parallelism but there isn't one proper definition. To put in simple words, parallel computing means to break the list of serial instructions into several parallel sets of instructions.

NERD: What would you like to say about the present status of Parallel Computing?

Fran Allen: It is a mess. Don't quote me on it (Laughs). Rather than big machines, problems at lower end, that is, say hand held devices, are being tackled currently. These devices have higher and higher expectations. Multiple operations done at once, I forget the exact term for it, is in vogue for these devices.

NERD: Tell us about a remarkable experience you had at IBM?

Fran Allen: In one particular summer, some students from the University of Chicago had come to IBM for research. At the end of the summers they produced remarkable results. One of those students joined IBM, and he went on to make several significant achievements. He was the first executive in IBM to blog. His idea was that everyone should blog because blogging is a way where you can present your personal ideas which could not be presented otherwise. He is currently at MIT.

The way he seamlessly combined his work and life was a great inspiration and we felt that we could be more in touch with ourselves even when we worked. This is one of the remarkable and memorable things which happened during my tenure at IBM.

NERD: Tell us something about what you are doing currently.

Fran Allen: My work in the field of computing is still going on. These days I spend a lot of time writing recommendation letters for people whom I know, especially for women, whose work has been overlooked. It gives me a lot of satisfaction.



Frances Allen

I also like probing the ideas, where they originated from and how they developed. Say for example parallelism. So I am also working on a history of the idea of parallelism and associated ideas in computing.

I also like to formulate views on various things. I have always liked starting new things with people, though I have not been necessarily finishing them up. But I still like to take up new initiatives. And I have been doing that. Other than that I am climbing mountains (Laughs), going on expeditions and studying environmental issues also.

NERD: Did you face any challenges as a woman scientist?

Fran Allen: There weren't any problems at IBM. I was not the first woman at IBM. In fact, I was one of the many. I became a manager at IBM in 1959. In my division, however, there were four peer managers and only three women in all but none of us thought it to be unusual. There were some disadvantages in the day to day workplace. I liked to work on new and interesting things which colleagues did not always find good. However I would say that this was not due to the fact that I was a woman, but because of the type of the work.

NERD: How does it feel being the first female IBM fellow and the first female Turing Award winner?

Fran Allen: It's interesting. I see this as an opportunity for change. However, I am

disappointed by the fact that though this field has been there for 50-60 years, yet I am the first. There appears to be mismatch of some sort. Many more women should have been there. It is discouraging to see that percentage of women has not changed much.

NERD: What do you think could be reasons for percentage of women not changing much?

Fran Allen: I really don't have any idea. It appears that this is not a problem in Eastern Europe. I was attending a Multi-core conference in Romania, and when I tried to discuss this issue, I found out that 40-50% undergraduates are women. Elsewhere, the problem is persistent.

NERD: What should be done to change the situation?

Fran Allen: I think bringing out the achievements of women scientists in front of the people can be a solution of improving the attitude towards female researchers. Other than that dedicated programs for girls can also help. I am pretty sure there might be such scholarships here too. We can work further on those lines.

NERD: What is your take on Undergraduate Research?

Fran Allen: Research at undergraduate level is very important. It is very necessary to get the basics of research during the undergraduate program. Learning at Undergraduate level and elsewhere must be embedded with solving creative problems. Several institutes in US have been focusing on Undergraduate research.

“Research at undergraduate level is very important.”

There was a programme in CMU for prospering the idea of research in young women. At the end of the programme, nearly all the participants of the programme had made up their mind to go to graduate school. Similarly, there was a programme in Harvard University,

though it was confined only to the field of robotics. Yet the basic idea was to inculcate the feeling of research among Undergraduates.

NERD: What message would you like to give to the students here at IIT Kanpur?

Fran Allen: I am immensely impressed with the talent and intellectual environment that I have seen here. Model of mentoring each other and building network is pretty much unique to IITK. This is about helping each other. The sad thing is that it is not being replicated and it would be good to widely replicate this. It has to be a bottom-up movement, a building role and that is going to bring the whole system up. It is missing in US universities also. My message is that this system of helping each other has to survive and students should assume their roles in it.

The connection between this university and women here is positive and that is something that should be continued at all costs.

NERD: Thank You madam for giving us time. It was a great experience to be with you.

Fran Allen: I had a great time too! This is one of the best interviews I have ever had. I wish you luck for all future endeavors.

Acknowledgements

NERD Team would like to acknowledge the help received from Professor Manindra Agrawal, HOD, Department of Computer Science and Engineering, IIT Kanpur, for arranging this interview on a very short notice amidst Fran's busy schedule!

Ponder Yonder

To know more about Fran visit:

http://en.wikipedia.org/wiki/Frances_E._Allen

and associated references and external links.

http://domino.research.ibm.com/comm/pr.nsf/pages/news.20020806_fran_allen.html.

Nishith Khantal is an alumnus of IIT Kanpur of the Class of 2008. A very intelligent and extremely able person, Nishith maintained a very vivid profile of activities with a very successful academic spell in the Department of Computer Science and Engineering and an equally successful stint with a number of extra-curricular activities holding positions like the President of ACA and the Finance Convener of Students' Gymkhana. He is currently working at Microsoft Live Search in Vancouver, Canada.

Evolutionary Computing:

Darwin and Lamarck Fight It Out (Again)

Shish Basu Palit

E*ditors' Note*
This article is the first contribution from a student of newly inducted Y8 batch. We wish to take this opportunity to appreciate the interest and commitment that the author showed for NERD so much so that this contribution came even before the batch was here for orientation! We hope that the author will continue contributing for NERD and that all the new students will take a leaf out of his book, proclaim being N+ and join the NERD HERD by contributing! Meanwhile, please go on for an interesting read on evolutionary computing.

Introduction

Today, the name of Charles Darwin is inseparable from the idea of evolution. However, Darwin was not the first to present a scientific theory of evolution. Half-a-century earlier, Jean-Baptiste Lamarck had advanced a theory of evolution. In fact, he was the first person to propose a complete physical and cohesive theory of evolution, and his views were widely accepted until Darwin arrived. He contended that evolution occurs because individual organisms try to gain attributes that will help them survive, and they subsequently pass on these acquired traits to their offspring.

To take a famous example, evidence shows that evolution has continuously given giraffes longer necks. Lamarck explains this easily by saying that every giraffe continually strives to make their neck longer in order to get at the leaves higher up in the tree. Then they pass on their lengthened necks to their offspring, who make it longer. In this manner the neck of giraffes gets successively longer. This is certainly the common-sensical, logical explanation. However, as we know today, it is

simply not true. It is not true because physical traits acquired during the lifetime are not transmitted to offspring, only genetic codes are. No matter how long a giraffe makes his neck during his lifetime, his sons and daughters don't get any part of it. Yet the neck length of giraffes is clearly increasing. What then can be the explanation?

That is when Darwin came in. He published "*On the Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life*", one of the most important and revolutionary books in the history of humanity. Darwin's idea was astounding in its simplicity and power. At the same time, it is so obvious yet so alien that two hundred years later we are still struggling with it. Darwin's theory, in its modern form (often known as **Neo-Darwinism**), holds that evolution occurs, not by some purposeful striving towards a goal, but by 'natural selection' among random variations.



Going back to our example, giraffes will have the same neck length until, purely by chance, the genetic code of one individual undergoes a mutation that makes its offspring have a slightly longer neck. Since this mutation gives those offspring an advantage in getting food, these offspring will tend to survive more than the unmutated individuals. More importantly, they will tend to have more offspring. In this struggle for existence, the short-necks will slowly die out and the long-necks comprise the entire population.

Then one day, a long-neck will undergo a random mutation that will make its offspring (but not itself) tend to have an even longer neck, giving it an advantage, and the

machinery of selection will kick in once again. Over the time of this constant process, Nature sieves a population of giraffes of many neck-lengths to retain only the longest. This will result in giraffes having longer and longer necks. This is, roughly speaking, Darwin's theory of natural selection.

Though Darwin's theory has a stunning beauty that characterizes great theories of science, it is not difficult to realize that it is not as straight-forward as Lamarckism. It is an idea that seems obvious when explained, but only an exceptionally clear and creative mind could come up with it. Today, no one doubts that Darwin was right and Lamarck was wrong. The battle would seem to be settled for good, but is it?

Parallels with Lamarckism in Traditional Computing

The traditional paradigm in computing (as in every other science) has been that the computer scientist would study a problem, consult the existing (and ever-growing) library of algorithms, and try to develop a program that will accurately and efficiently solve the problem. When she solves the problem successfully (and publishes her result), the program used by her enters into the library. Future scientists can use that to solve problems, often the same one in a better way. In this way we get ever-more complex and efficient programs. The parallel with Lamarck's theory of evolution is not hard to see.

In comes Evolutionary Computing

However, history would tell us that this is not the only way. Computer Science is being revolutionized by a group of completely new computational techniques, and a major one among them is the paradigm called **Evolutionary computing**.

The basic approach of evolutionary computing is quite simple. First the problem to be solved is modeled, often as an **optimization problem**, a problem where the goal is to find the minimum value of a function (called the **cost function**) given certain constraints on its inputs. Essentially it's the same thing as the maxima-minima problems taught at school.

Secondly, several candidate solutions to the

problem are designed (or randomly generated). Finally, the crucial step is that these solutions are allowed to *evolve* by themselves. The process is closely modeled on real-world Darwinian evolution. Each of the solutions in the population is allowed to make copies of itself. However, certain random variations are introduced into these copies, mimicking mutation. The process is called a **mutation operator**. There are new, randomly generated candidate solutions in the population.

Now, the population is subjected to a selection procedure. Each of the solutions is tested for their performance in solving the problem. For that, a function is constructed, called the **fitness function**, which measures how close the solutions are in solving the problem. Those solutions that rank towards the top are allowed to continue, while the others are removed. The remaining population then undergoes reproduction and selection again. This is 'natural' selection with artificial criteria for survival. The process is iterated many times, until further iterations have little effect on the performance of the solutions (in case of optimization problems, this implies solutions that closely approximate some local optimum).

A variation on this procedure mimics sexual reproduction, where daughter solutions are obtained by combination of the two parent solutions. This creates more variation in the population to select from, potentially increasing efficiency. The operator that takes two parent solutions and generates daughter solutions is called the **recombination operator**.

Everyone familiar with the success of Darwinian evolution (which produced us, the most versatile problem solving machines known), the Evolutionary computing paradigm should have immediate appeal. However, a problem is also immediately apparent: how will a mutation operator operate? The most widely used method is also perhaps closest to reality: **genetic algorithms**.

In this method, a general structure of the solution is decided upon, and then parameterized by a set of variable numbers. This set of variables is called the **chromosome** or **genotype** of the solution (also called the

phenotype in this context). This is similar to parameterizing a function by several adjustable constants in analytic geometry.

The mutation and recombination operators then acts on the genotype, randomly varying the parameters and then building the solution phenotype from them. This resulting solution then undergoes the selection procedure. This is very similar to real world evolution of single-celled organisms, where only genotypes get mutated but only the individual is directly selected.

An example (Introduction only)

Let us take the example of a classic textbook problem in computation, the knapsack problem. In this problem, there is a given set of N items (I_1, I_2, \dots, I_N) each with an associated weight $W(I_k)$ and value $V(I_k)$. A selection of these items must be put in a knapsack, subject to the condition that the knapsack can only carry items up to a maximum total weight T . The problem is to maximize the total value of items put in the knapsack. Each solution can be modeled by a string of N binary digits X_k , where 1 represents that item being in the knapsack, and 0 represents it being out. The constraint condition then is:

$$\sum X_k W(I_k) \leq T$$

and the cost function (the function to be minimized) is:

$$C(X) = \sum X_k V(I_k)$$

The mutation and recombination operators will act on this string of digits and the selection procedure will select those strings that satisfy the constraint while giving low values of the cost function.

No free lunches!

Often, the selection process is not completely deterministic. Just like real-world evolution, there is a small probability that less fit solutions may get selected. Once again, the advantage of this is greater variety in the population, while the downside is loss of efficiency since the presence of less fit solution may cause the process proceeds more slowly (take more time to come to the desired solution). However, the introduction of

probabilistic selection introduces genetic drift that under certain conditions may lead the process to converge on sub-optimal solutions (which might be good but not good enough), but this can usually be avoided by keeping the population large.

The need for diversity may not be immediately obvious. After all, selecting only the best should produce results fast. However, when the diversity in the population falls off rapidly, it is far easier for the population to get boxed into local optimums. That is, the population may stabilize at a solution that is better than those immediately around it in terms of variation in genotype, but there may be better solutions further away in the fitness landscape.

Visualize a landscape where there is a central pit, but the descent into it is littered with smaller holes. A ball rolling down may get stuck in one of the smaller holes because it is surrounded by points locally higher, even though there is a much lower spot beyond that. In fact, some implementations try to avoid this by actively penalizing fitness when solutions get too clustered. This is an inevitable trade-off between accuracy and efficiency.

The matter is further complicated by the fact that the imaginatively named *No free lunch theorem* holds that, roughly speaking, all methods of problem-solving are essentially equivalent (in performance) when their performance is averaged over all possible problems. Because of this fundamentally important result of theoretical computer science, there can't be any one solution that can solve any random problem with very high efficiency and accuracy and hence solutions must be tailor-made for specific problems.

End Notes

The success of Evolutionary computing is in large part due to the fact that it makes few assumptions about the problem, unlike a human programmer. Objective solution among a large population of random candidates often gives better results than the conscious efforts of a programmer who is conditioned by experience to think only in certain ways.

Another trend seems to be that methods that are closer to how evolution operates in reality

also seem to give better results in computation. It is not immediately obvious why this should be true, or even whether this is true. We seem to be approaching the natural method from the opposite direction. Perhaps the best human engineering can do is mimic Nature, which has an uncanny ability to come up with amazingly elegant and efficient solutions to the most difficult of problems.

It is too early to say whether Evolutionary methods will prove to be substitutes, or even general alternatives to traditional computing. But looking towards history, should we be too surprised if Darwin once again triumphs over Lamarck?

Ponder Yonder

1. *The Selfish Gene* by Richard Dawkins (3rd Ed. 2006); a brilliant, influential, controversial, eminently readable and immensely popular introduction to evolutionary biology. Essential reading.

2. *The Extended Phenotype* by Richard Dawkins (Revised Ed, 1999); a slightly more technical sequel to the previous work.

3. *Evolution* by Nicholas Barton et al (2007); a modern introductory textbook on evolution, fairly accessible.

4. *Evolutionary Biology* by Douglas Futuyma (3rd Ed 1997); a classic reference work.

5. *Introduction to Evolutionary Computing* by Eiben and Smith (2007); an introductory textbook, fairly accessible.

6. *Foundations of Genetic Programming* by Langdon and Poli (2002); a more advanced and mathematically rigorous text.

7. http://en.wikipedia.org/wiki/Evolutionary_computing and associated links.

Shish Basu Palit is a first year undergraduate student in the Department of Mathematics and Statistics. Hailing from Kolkata, he is interested in computers, photography, books and music, and the things he dislikes are getting up early and learning by rote. Visit his Wikipedia page at <http://en.wikipedia.org/wiki/User:Loom91>.

(continued from page 2)

WIRED

"It is certainly a great initiative and it was extremely tempting for me to jump into this."

Mr. Hari Kumar, Department of Mechanical Engineering, IIT Kanpur

"Excellent idea! For all the help you require just count me in. It's on!" **Professor Manoj Harbola, Department of Physics, IIT Kanpur**

"I am happy to note that such initiations are taken up by student community for a healthier research environment." **Ms. Deepika Sachdeva, Department of Materials and Metallurgical Engineering, IIT Kanpur**

"Thanks for such a wonderful NERD edition you all came up with." **Mohit Singh, first year undergraduate** on NERD Vol1 No.0 (sent specifically to first year students by post).

"Beautifully organized! I would love to contribute in any way I can." **Parnika Agarwal, first year undergraduate** after reading NERD Vol1 No.0.

NERD Replies: Dear Mohit and Parnika, Thanks a lot! We hope that you will join the NERD HERD and

contribute for bringing out the magazine.

"NERD is indeed a very good effort to create, to nurture and to enhance the general interest and excitement about science and technology. I hope this platform will help students discover the budding scientists within themselves." **Professor Animangsu Ghatak, Department of Chemical Engineering, IIT Kanpur**

"With the quality of the newsletter as it is, it's not worthy of being sent to first year students along with the CS Brochure." **Rupesh Kumar Srivastava, Department of Mechanical Engineering, IIT Kanpur**, on NERD Vol1 No.0

NERD Replies: Dear Rupesh, Thanks for giving a frank feedback. We request you to join the NERD HERD because we really need people for pointing out the shortcomings and helping us in removing them.

"Good! It's a great initiative. But sustainability is THE issue. You should create a repository of articles to ensure regularity of the magazine. Think of the next NERD while publishing the current issue. Give ownership to people who are most likely to take it forward." **Professor Sudhir Jain, Department of Civil Engineering, IIT Kanpur**

And the list continues...so will NERD!

Takneek'08: Its coming!

Days of cramming multiple choice questions and axioms are over now. It's time and opportunity to gear up for Takneek'08: The Intra-IITK technical festival.

Takneek is a precursor to the colossal national level technical festival of IITK, Techkriti. Especially for the freshers, it is the first exposure to the painfully non-ideal side of engineering. The competitions held in Takneek make the participants realize that what they learn in their textbooks and lectures has to have an application. For example, in Takneek'07, there was a person who, in order to locate an object ahead, suggested using the Doppler Effect!

Having a brief look at Takneek'07, many competitions were held by the clubs of the Science and Technology Council. Robotics Club asked the participants to make a 'Line Follower' Robot which autonomously followed a white strip pasted on the floor. Aeromodelling Club assigned the task of making gliders using balsa wood to the students and the time of flight and distance

traversed by those gliders decided the winner. Electronics Club held a competition in which a device had to be made to gauge the reaction time of a person. The winners of this competition did a marvellous job by adding a touch of originality, making it a game where two players could see whose reaction time was lesser. It was a great learning experience for all the participants and the level of dedication and energy among them was at its acme. This novice level was of great help for them while preparing for the much bigger and tougher arena of Techkriti.

Fortunately, this year we have Science and Technology Secretaries (SciTech Secys) in UG hostels. Moreover, the overwhelming response in the introductory lectures and workshops of Electronics and Robotics Club has boosted the confidence of the organizing team. They are expecting a much greater level of participation in Takneek'08. We are sure that Takneek'08 will be hosted at an unparalleled scale.

Students are requested to stay in touch with their SciTech Secys for the latest developments related to Takneek'08. See you all there!

What's up next?

Highlights of Vol. 1 No. 2 of NERD:

- **Get Smart with 'Smart Cards'** (Notes on Smart Card Identification System developed at IIT Kanpur) - by Avirishu Verma
- **Guns and Lasers** (Microstructure engineering)- by Gaurav Mishra
- **GASE (Group on Alternative Sources of Energy)** - by group members
- **SHE** – by Parul Singh
- **DOG-EARED : A drug is born** (Book Review) — by Arvind Kothari

And many more articles..... Don't forget to grab your copy.





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nerd@iitk.ac.in
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