May 2010
Vol 2 No. 3

An IITK Students' Publication

nerd

Notes on Engineering Research and Developement

Beyond the Veil of The Universe
About the Hubble Telescope

Soilless Culture
Hydroponics

Redesigning the distribution
Modelling Facility Location on Supply Chain Networks

The Emerging Biofuel
Biobutanol

Just A Second
Cloud Computing

The Indian Drug Research Scenario
Interview With
Dr. T.K. Chakraborty

Throwing stones at the foundations
Interview with Dr. Anthony Leggett

CONTENTS

Team -
IIT Kanpur:
1. Arvind Kothari
2. Mohit Kumar Jolly
3. Kirtimaan Mishra
4. Rishabh Chauhan
5. Bhuvnesh Goyal
6. Pranjal Nayak
7. Utsav Kesarwani
8. Puneet Singh
9. Vardhan Srivastava
10. Aayush Gupta
11. Akshay Chawla
12. Gaurav Krishna
13. Divija Rao
14. Jyoti Gupta
15. Kavya Sudha
16. Kritika Singh
17. Neha Lahri
18. Punit Kr. Singhal
19. Prateek Mittal
20. Rohit Upasani
21. Shubham Deva
22. Smriti Agarwal
23. Vidit Jhindal
24. Vishal Nagwani.

IGIT, New Delhi:
Sushmita Malakar

AMU:
Ibad- ur-Rehman

Cover pages Design:
Vidit Jhindal

Layout:
Neha Lahri
Smriti Agarwal
Bhuvnesh Goyal

Cover Page Photo:
Saurabh Chawdhary
(saurabhc@iitk.ac.in)

The photograph on the cover page is of the Airstrip, IIT Kanpur

The Year of NERD
Musings from the Editor's Desk

You hold in your hands NERD volume 2 number 3. It has barely been a month since the previous issue came out. Nevertheless, here it is.

It has almost been around 18 months since the release of first issue of the magazine NERD on September 5, 2008. Looking back into the past reminds us from what and where we had begun, with a raw idea in our minds. Now, the idea is fully flourishing in the hands of an enthusiastic team and a vulnerable audience. The magazine has witnessed not only pleasant spring during the initial phase, but also faced the challenges of terrible winters during its tenure in the form of lack of suitable content, discontent and discouraging attitude from a few people and much more. But it feels good to overall produce a better furnished output, rectifying the previous mistakes which the critics pointed out and hence a learning lesson for the team.

This year also saw a burst in student activities in the scientific domain through ICARUS and SCoPE. ICARUS (Indian Conference on Academic Research by Undergraduate Students), a three day event aimed at bringing undergraduate research in light. It faced its shares of difficulties as any initiative does for the first time, but concluded successfully all the same. SCoPE (Science Communication and Public Engagement) lecture series, initiated by NERD this year, was graced by the contributions of Dr. Pradeep Srivastava, Dr. Manoj Patairiya, Dr. Arvind Gupta, Mrs. S. Priyadarshini and Dr. K. L. Chopra. We hope to bring forwards more lectures by elite science communicators and journalists in the near future.

We acknowledge the priceless contribution by Dr. Manoj Harbola while he was on the post of the Project Investigator (PI) of NERD, for keeping us on track throughout. On the same note, we are thankful to Dr. Anurag Gupta, who has agreed to be the PI of NERD. We wish to have a wonderful association with you sir, thank you very much. We are immensely grateful to Dr. K. Muralidhar, our mentor, who has helped us shape this magazine into what it is today through innumerable discussions held with him.

Again, we have contribution from beyond the walls of IIT Kanpur. There are two articles from Aligarh Muslim University. One article is from Dr. Jawaid Alam Patna, who came in contact with two NERDs in International Conference on Hands-on Science 2009, Ahmedabad. Pranjal Nayak graces the issue by re-initiating DOG-EARED.

The vision to Create, Communicate and Contribute to all in terms of science articles, struggling pasts and successful present of eminent personalities in the form of interviews, new plans, top class initiatives etc. has always been an important source of the article repository. Coming to this issue again, certain changes have been with respect to the previous issues. For the first time, we have incorporated a photograph of the campus as cover page, because Dr. Anurag Gupta rightly says, "There is already enough technical content inside." Nevertheless, it reduces the team work load and enables us to focus on some other facts which require proper attention.

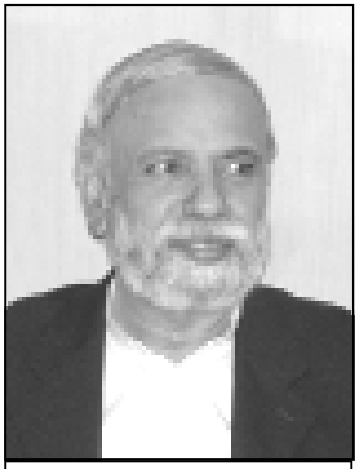
The next semester, NERD doesn't wish to limit itself to publishing front and SCoPE, but also plans on organizing a whole new set of competitions for the campus junta. Keep your ears open for such news!

Regards,
Editor, NERD

CREATE,
COMMUNICATE,
CONTRIBUTE!!

The Indian Drug Research Scenario

Bhuvnesh Goyal, Mohit Kumar Jolly and Pranjal Nayak



Dr. T.K. Chakraborty

Dr. T.K. Chakraborty is the current Director of Central Drug Research Institute (CDRI), Lucknow. CDRI is among the thirty seven laboratories that are functioning under the aegis of the Council of Scientific and Industrial Research (CSIR), and is a pioneer research organization in the field of biomedical research. The very latest techniques and methodologies are employed for developing new drugs and diagnostics to combat diseases prevalent among mankind in general and Indian population in particular (www.cdriindia.org).

Dr. Chakraborty specializes in organic synthesis (especially total synthesis of natural products), peptides and peptidomimetics, drug design and molecular modelling. He has received many awards, the most important one being the Shanti Swarup Bhatnagar Prize in Chemical Sciences (2002). He is also elected Fellows of all the three science academies in the country. NERD team members had the privilege to talk to Dr. Chakraborty about the Indian drug research scenario and its challenges. Here are some of the excerpts from his interview:

NERD: You are the director of CDRI (Central Drug Research Institute), Lucknow. Please tell us something about CDRI.

Dr. Chakraborty: CDRI started on 17th February 1951, when India was one of the poorest countries in the world and our average life expectancy in those days was only 32 years. At that time, our leaders felt the need to have a modern drug discovery research institute so that the general health of the public of this country can be taken care of.

Our country used to follow a different patent regime in those days. Most of the rules and regulations were in favour of the multinational companies and the drug prices in our country were one of the highest in the world. In 1970s, a new patent regime called as the Process Patent Regime was started, according to which everyone was allowed to make the same known drug in different ways and then, besides CDRI, many other institutes in the country like the Indian Institute of Chemical Technology (IICT), and National Chemical Laboratories (NCL) joined in the development of processes for making known drugs. We mastered the reverse technology – as soon as we came to know about a new drug being discovered by multinational companies, we started working on how to make it by a different route, synthesized it in the lab and gave it to the industry to produce it. That way the drugs became available in the country and at affordable prices too. Today India has an estimated 24,000 drug manufacturers. Together they produce output valued at nearly US $18 billion (estimated to grow about 12% annually), accounting for a fraction of our gross domestic product (GDP). The Indian pharma industry stands today 4th (8%) in terms of volume and 13th in terms of value of production, and has nearly 22% of the global generic market.

But in 2005 we went to different international patent rules and regulations – entered the Product Patent Regime, according to which once there is a product in the market, you can't make that by any other means and produce it. At CDRI, we have been trying to develop new drugs from the inception and are better equipped than any other in the country to handle the new challenges. But our resources are limited – a government funded drug discovery institute has been competing with the multi-national companies who are spending billions of dollars for drug development and hence we are in dire need of a very committed programme to keep us progressing.

NERD: What are the major research areas being studied in CDRI?

Dr. Chakraborty: The research areas that we have chosen are in such a way that our research becomes relevant to our country, so that we don't do what every multinational company does. We work on developing drugs for parasitic diseases like malaria, leishmania and filaria which are very prevalent in our country. We also work on tuberculosis, microbial diseases, diabetes and cardio-vascular diseases

wide spread across India. Family welfare and planning is a major area on which we have been working for many decades and it is being supported generously by the Ministry of Health and Family Welfare especially for women health. We also introduced a contraceptive pill, 'Centchroman' in the country and sold the technology to Hindustan Latex Limited. This is the most successful 100% indigenous drug discovered in India to date. HLL manufactures and sells it by the brand name 'Novex' and the OTC version is sold as 'Saheli'

NERD: You did your B.Sc. and M.Sc. in chemistry and Ph.D. in Organic Chemistry. How did you shift to the research interests of drug design and molecular modelling?

Dr. Chakraborty: More than 80% of the drugs that are used today are small molecule drugs. They are organic molecules and not biological protein based drugs or vaccines, so, in that way, organic chemistry plays a very important role in the development of new drugs. All organic chemists come to know about the biologically active molecules and start synthesizing molecules in the laboratories starting from paracetamol to many other structurally complex drugs. There are many synthetic molecules which are drugs, so synthetic organic chemists get naturally interested in the area of drug development.

"Unlike multinational companies, we choose research areas that are relevant to our country."

NERD: What breakthroughs or paradigm shifts in drugs research do you foresee in near-future? Are there any immunological avenues that have been explored little but hold potential for completely new approaches to medicine?

Dr. Chakraborty: The future is about personalized drugs. Each individual is different from the other so a drug which may be effective for you may not necessarily be effective for a second person, so we are approaching towards personalized drug discovery regime where a particular drug would be developed to be exactly and optimally suitable for a particular person. We have protein receptors in our body, to which pharmaceutical drugs (or signalling molecules) come and attach. These receptors are involved in many functions of the cell because they regulate different path ways in the cell. So effecting or blocking one particular receptor or protein may have a cascading effect on the whole biological process. Today, people are trying to understand a holistic view of a particular receptor or a protein and its role in the cell and try to understand how effecting the receptor shall affect the other functions of the protein, or how it can have a synergistic effect. Is it by blocking more than one function of the cell makes the drug more effective to control the disease? These are some of the current efforts in the field of new drug discovery programme in CDRI.

NERD: What are your views on alternative systems of medicine, particularly traditional medicine like Ayurveda?

Dr. Chakraborty: Traditional medicines like Ayurveda are effective, but we need to put them under the modern drug discovery programme so that they get rationalized and standardized so that each and every time you take an extract it should be as effective as it was before. We know that people have been using it for thousands of years, but we need to get it validated from the modern science aspect, and make sure that it has no toxicity or side effects.

NERD: You have worked in total synthesis of natural products. Why is it that the molecules whose biosynthesis is so amazing and elegant naturally are very difficult to synthesize in the laboratory?

Dr. Chakroborty: We are a long way to go to or even try to match the efficiency of Mother Nature and how it produces such complex naturally occurring molecules. If you look into the building blocks that Nature uses, they are very simple - just 4 nucleosides - A (Adenosine), T (Thymine), G (Guanine) and C (Cytosine), and consequently 20 amino acids. Using different permutations and combinations, Nature has been able to produce a vast array of complex compounds. In laboratories, we have not yet reached the stage where we can replicate how Nature does it but we can at least try to learn the process how Nature is doing it and try to synthesize our molecules and make them in the laboratory more efficiently. In many stages and processes, we try to mimic the natural production and we try to make the chemicals which Nature produces, not exactly the same way but in slightly different ways so as to optimize the efficiency. We try to see the structures and functions of those molecules and design molecules which will look almost like the natural product but will not exactly be natural and yet will have the same efficiency and effectiveness.

NERD: What are the most interesting challenges in total synthesis today?

Dr. Chakraborty: Total synthesis is something I'd

compare with a game of chess - there are rules and regulations that this can move two and half room and that one can move diagonally and once you have these set of rules, you have to make the combination of these different moves. Total synthesis can become very efficient and if you know how to economize it and the number of steps to be used, you can pursue a synthesis very efficiently. Most of the organic chemists have gone through the same training procedure, hence many a times there is an overlap - the way I'm trying to synthesize a molecule is very similar to somebody else's method. If you are not that quick enough, somebody else will synthesize it and publish the paper or patent the process, but what makes you great is how differently you have been able to think within that framework and still come out with a synthesis that is very efficient and different. Intuitiveness is the key. Our goal will be to make the molecule in the lab with less number of steps and more efficiently and in a very elegant way. The challenge is always there, like climbing the Mt. Everest - how you'll climb, which route you'll take, what is the shortest and the most efficient route will depend on how efficient climber you are.

"Boundaries between organic, inorganic and physical chemistry are disappearing."

NERD: CDRI came up with the world's first non-steroidal oral contraceptive. What effect it has made on women health in the country?

Dr. Chakraborty: If you consider the family planning scenario in our country, it is still the women who have to make the choice. In a recent report that I saw in newspaper, some of the hospitals during a particular period have registered 15000 cases where women have undergone the family planning procedure of different forms, while only 2 men have participated in the whole programme during the same period. You see the difference clearly.

What we have developed is a contraceptive pill, which women have to take just once in a week and not continuously every day. This pill is devoid of any side-effects and other complications associated with many other oral contraceptives. This wonderful drug is also finding various applications in other cases of women health like dysfunctional uterine bleeding and may also be effective against breast cancer etc. on which we plan to undertake more detailed study. It is already being manufactured around 1000 kg per annum by Hindustan Latex Limited (to whom we sold this technology) and very soon it shall be 2,000 kg per annum. CDRI feels very proud of this drug as it has changed a lot about women health in our country.

NERD: Emergence of highly drug-resistant strains of germs is an increasing concern these days. Do you think this is an effect of the improper use of medicine or a necessary by-product of our increasing drugs-dependence as a civilization?

Dr. Chakraborty: It is anti-microbial drugs against which some strains of germs develop resistance, and this resistance keeps changing as a result of fast mutation. We sometimes don't follow the proper choice or course of the drug which the physician prescribes to us. If you have to take some anti-microbial drug for a course of 5 days, you take it for 2 days and you discontinue because you feel that your disease has subsided and you no longer need it. It is due to this practice that some strains of germs develop resistance towards that particular drug and so later on the same drug would not work for you again.

These strains are also too smart! They change and manipulate themselves, undergo mutations and become resistant to various drugs and keep us awake all the time. In case of tuberculosis, for example, you have new resistant varieties getting to be known every now and then.

NERD: How do different branches of chemistry-physical, inorganic and organic intermingle to get to the field of drug design and development?

Dr. Chakraborty: Science is becoming more interdisciplinary in nature so the boundaries of organic, inorganic, physical are slowly disappearing. Today you find an organic chemist well converts into the areas of bio-chemistry because the understanding of the biological processes is very important for us in terms of betterment of our health. An inorganic chemist tries to understand which minerals are required for our daily intake, and many proteins and other molecules dependent on minerals and metals. Physical chemistry is required to understand the enzymatic pathways of the proteins, as the kinetics and the dynamics of enzymes and receptors play a very important role in our body.

These days you can also see a computer scientist becoming a systems biologist, like Hiroaki Kitano, President of the Systems Biology Institute, Tokyo, Japan. He is basically a computer scientist who is modelling the whole biological system and trying to see how one perturbation in a cell has a cascading effect on the other parts of the body. This is known as Systems Biology. Internationally, many topmost biologists today are actually chemical engineers – like Bob Langer, Jay Keasling, Chaitan Khosla and many others. This is wonderful to see people with

such diverse backgrounds coming into biology, and I would also suggest students from institutes like IITs should come and work in some of the biology labs in the country like CDRI and get exposed to the exciting research being carried out there. We should follow a policy of 50% courses in the area a student majors in and the rest of courses should be made optional to be chosen by students based on their own interests.

NERD: There is a big controversy regarding patents of drugs. Those in favour of less patents say that the pharmaceutical giants deny poor people the right to live with their high-priced patented drugs, while the companies claim that the increased profitability from longer patents is needed to motivate drugs R&D. What is your opinion on the issue?

Dr. Chakraborty: I've already discussed one point about the Process Patent Regime. Today life expectancy in India is about 65 and we have affordable drugs, but as we are progressing and becoming economically quite strong, we should have the capability to build new molecules. Why would these pharmaceutical industries not want to exploit the whole world? They discovered the molecule so they try to protect it as much as they can through the Product Patent Regime. We are also a signatory of this one, so we can't shrug off our responsibility saying that this is a life saving drug and they should have no power to control the worldwide market, rather it should be our effort to discover a new drug/ molecule for a particular disease and show that the drug developed in India is globally acceptable and is sold in countries like US. We must remember that in spite of our tremendous growth in production of generics and new process formulations, the share of India's pharmaceutical industry in the world market is a mere 1.3% of a global sale of nearly US $785 billion (likely to be $820 billion by the end of 2009). Now what we are doing is that we try to manipulate an existing product, which we expect will get permission to be sold due to the low price. We don't follow the product patent regime for life saving drugs but if the disease is not so prevalent, then it is possibly not justified that we expect us to be protected. I think that we must have the confidence that we'll try and make a product which is globally acceptable - not necessarily a drug, it could be in any field. When your level of expectancy goes up, your level of efficiency also goes up to meet the global challenge.

"I suggest students of IITs to come and work in biology labs of India like CDRI to get a taste of research being carried out here."

NERD: There is a big controversy regarding patents of drugs. Those in favour of less patents say that the pharmaceutical giants deny poor people the right to live with their high-priced patented drugs, while the companies claim that the increased profitability from longer patents is needed to motivate drugs R&D. What is your opinion on the issue?

Dr. Chakraborty: I've already discussed one point about the Process Patent Regime. Today life expectancy in India is about 65 and we have affordable drugs, but as we are progressing and becoming economically quite strong, we should have the capability to build new molecules. Why would these pharmaceutical industries not want to exploit the whole world? They discovered the molecule so they try to protect it as much as they can through the Product Patent Regime. We are also a signatory of this one, so we can't shrug off our responsibility saying that this is a life saving drug and they should have no power to control the worldwide market, rather it should be our effort to discover a new drug/ molecule for a particular disease and show that the drug developed in India is globally acceptable and is sold in countries like US. We must remember that in spite of our tremendous growth in production of generics and new process formulations, the share of India's pharmaceutical industry in the world market is a mere 1.3% of a global sale of nearly US $785 billion (likely to be $820 billion by the end of 2009). Now what we are doing is that we try to manipulate an existing product, which we expect will get permission to be sold due to the low price. We don't follow the product patent regime for life saving drugs but if the disease is not so prevalent, then it is possibly not justified that we expect us to be protected. I think that we must have the confidence that we'll try and make a product which is globally acceptable - not necessarily a drug, it could be in any field. When your level of expectancy goes up, your level of efficiency also goes up to meet the global challenge.

NERD: Biomedical researchers have a direct relevance to the society. What kind of social and ethical responsibility is incorporated in their research?

Dr. Chakraborty: Of course, all our research work has to go through the scrutiny. Say I want to bring out a new drug in the market, so I will have to apply to DCG(I) and before that it has to go through ethical committees who look into the data to make sure everything is in order, and then only DCG(I) will give

the permission for carrying out different phases of clinical trials, before it approves to launch it in the market. All these safety aspects are looked into very carefully at different stages. What we need to stress upon is to make sure that the data generated in the country is accepted not only nationally but also internationally.

NERD: Share some of your interesting reminiscences from your college days.
Dr. Chakraborty: I can talk about it for hours. (Laughs) I think that the seven years I spent at IIT Kanpur as a student were the best days of my life. I can still walk through the corridors of IIT Kanpur with my eyes closed. What made our times different was the level of faculty members who taught and inspired us. IIT K Chemistry department faculty was and still is one of the best in the country – we had Prof. C. N. R. Rao, Prof. Goverdhan Mehta, Prof. M. V. George, Prof. S. Ranganathan, Prof. P. T. Narasimhan and many other wonderful teachers. Those days, I used to come to Lucknow almost every month for my spectroscopic studies in CDRI, but I could never imagine that one day I'll come here as a director.

NERD: Does CDRI offer any internship opportunities for undergraduate students?
Dr. Chakraborty: We have a summer fellowship programme, and we get B.Sc. students, and second year and third year engineering students to work in different areas like molecular biology, structural biology, bioinformatics etc. I would love to take IIT Kanpur students to do their summer projects at CDRI in these diverse areas.

NERD: Describe Dr. Tushar Kanti Chakraborty in one line.
Dr. Chakraborty: (Thinks) Most of the time I'm a good listener and some time when I get carried away then I do talk a lot and especially when it comes to talking about IIT Kanpur (Laughs).

NERD: What is your final message for the students?
Dr. Chakraborty: I feel that IIT system has the brightest students of the country and I want to tell them that the pleasure one gets from research is unparalleled and can't be compared to money. The country needs bright students taking to research, participate in nation building and meet challenges globally.

Reference:
An Indian effort towards affordable drugs: "Generic to designer drugs" – Bhupesh Taneja, Jyoti Yadav, Tushar K. Chakraborty and Samir K. Brahmachari Biotechnol. J. 2009, 4, 348-360 and the references cited therein.

Bhuvnesh Goyal (bhuvnesh@iitk.ac.in) is a second year undergraduate at IIT Kanpur. He is a member of core-coordination committee, NERD. He loves writing on wildlife and is very much interested in socio-biology.

Mohit Kumar Jolly (mkjolly@iitk.ac.in) is a final year undergraduate at IIT Kanpur. He is interested in science journalism and communication, and is one of the founders of NERD.

Pranjal Nayak (pran@iitk.ac.in) is a second year undergraduate at IIT Kanpur. He is a member of core-coordination committee, NERD.

Zonked!!

Piyush Srivastava

For want of a story! - Part 3
Welcome back to Roadland!! Our old friend MowTow (Does any Zonked! old-timer remember him from a year ago?) got interested in town-planning and has now abstracted one of his problems to the following game. There is a $2n \times 2n$ grid which is fully tiled with dominoes (2×1 rectangles). You are given an initial tiling, and a possibly different target tiling, and only the following move is allowed: you can choose a pair of adjacent dominoes which form a 2×2 square and rotate both the dominoes in the same direction by a right angle. What MowTow is wondering about is: Is it possible to always get from any initial tiling to any target tiling? Can you help him by giving him a counterexample or, otherwise, by showing that it is indeed always possible?

Send in your answer to nerd@iitk.ac.in latest by 30th May, 2010 and you can win a cash prize of Rs.1000!!

Piyush Srivastava graduated from IIT Kanpur with a B. Tech. in Computer Science and Engineering, and he is now a graduate student at the University of California, Berkeley, studying Theoretical Computer Science.

Soilless culture

Hydroponics

Md. Jawaid Alam

Introduction

Light, air, water, mineral salts and support for the root process are the pre-requisites for growth of plants. The first two (light & air) are provided by the nature while the other three (water, mineral salts and support) are provided by man through soil. If these can be provided by other media, then plants can be grown without soil also. Until 1929, the idea of growing plants without soil remained limited to laboratories. Then, Prof. W.F. Gerickey of California University succeeded in growing tomato vine twenty five feet height and named his discovery "Hydroponics" (from the Greek words "hydro" meaning water and "ponos" meaning labour).

The real work began in this area when it was undertaken by administrative departments, businessmen and commercial organizations. Under Grow-more Food Campaign (1939-45), the British Ministry of agriculture started taking interest in Hydroponics. In 1945, the air Ministry of London, took steps to commercialize soilless culture at desert base in Iraq, arid Island of Bahrain.

The first research study in "Hydroponics" in India was commenced at the government of Bengal's experimental form at Kalimpong in Darjeeling district in 1946. The most heartening research works were conducted by J. Shotto Douglas during 1946-48. Success was achieved after involving a novel method of soilless culture named "Hydroponics – The Bengal System". It is not claimed that hydroponics can replace agriculture entirely but it has been proved beyond doubt that all ornamental/foliage and flowering plants can be easily grown through this technique.

In 1992, yet another system came into existence by the joint efforts of Late Md. Manzar Alam (inventor of plant nutrition- BIO – FERT-M) and Md. Jawaid Alam (developing the soilless culture work). In this system, the method and material are entirely different and is known as "Alam Hydroponics method using Bio-Fert-M as nutrient". It is very easy to adopt and therefore is also called method of 30 drops (1 ml.) and 30 words. For growing Hydrophytic, Mesophytic & Xerophytic group of plants in unutilized spaces like verandah, balcony, drawing/bed room, where diffused light is available and roof tops and any vacant space where sunlight is available for flowering & fruiting plants, this method is used. So, it is also called "Garden without 4S" i.e. Soil, Sun, Space & Servant. Now with the available advanced and simplified technique of soilless farming everyone should adopt it and see for themselves how it works.

Motivation

I was motivated/ inspired by my father Late Md. Manzar Alam, who had a lot of love & affection for the plant & greenery since his childhood. His hobby of plantation led him towards the use of organic manure. I (the author), the elder son of Late Md. Manzar Alam was born and brought up in an environment where greenery and use of organic manure had been adopted on commercial level. This is the only motivation & inspiration of my all activities (production to implementation of the organic manure.)

Current techniques/ methods in use

The whole techniques/ methods of soilless culture are divided into two parts

(i) Material (Nutrition)

(ii) Method:

Nutrient solutions

Premixed nutrient solutions are available from a number of sources. They are relatively inexpensive and easy to use. When a person becomes familiar with growing plants hydroponically sometimes he/ she may wish to make his/her own nutrient solutions. The nutrient solutions are many and their requirement varies according to the crops.

Such nutrient solutions are as below:-

$Ca(NO_3)_2\ 4H_2O$	0.8 gm/Litre
KNO_3-	0.2 gm/Litre
KH_2PO_4-	0.2 gm/Litre
$MgSo_4.7H_2O$-	0.2 gm/Litre
$FePO_4$-	Traces Only
(i) Knop's Solution	

KNO_3-	0.1 gm/Litre
$Ca_3(PO_4)_2$	0.5 gm/Litre
$MgSo_4.7H_2O$-	0.5 gm/Litre
ZnCl	0.25 gm/ Liter
$FePO_4$-	Traces Only
ii) Sach's Solution	

$Ca(NO_3)_2$ $4H_2O$-	1.18 gm/Liter
KNO_3-	0.51 gm/Liter
KH_2PO_4-	0.14 gm/Liter
$MgSo_4.7H_2O$-	0.49 gm/Liter
Ferric Tartrate	0.005 gm/Liter
(iii) Hoagland's Solution	

$MgSo_4$-	0.5 gm
Double Superphosphate	0.5 gm
KNO_3-	1.4 gm
Ammonium Sulphate	0.3 gm
(iv) NBRI's Solution	

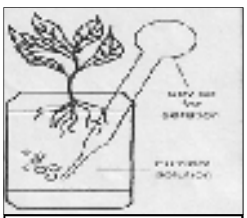
These combination are dissolved in 4.5 litres of water.

(v) BIO-FERT-M Solution

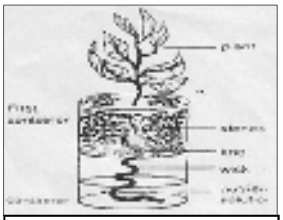
It is an organic liquid fertilizer; non-toxic and stable nutrition is derived from selected biomass and processed through microbial action. It is readily available in assimilable form (Alam & Alam, 1994, Alam et al, 1991).

It has inbuilt mechanism to manage without additional alterations in soilless culture, enhances photosynthetic ability of the plant, has phytohormonal properties for stimulation of germination, induces reproductive growth of plants, has been shown to have suppressive effect on fungal and viral infestation and is cost effective.

Bio-Fert-M (Aqua Spl) contains nutrition percentage by mass N-3.90, P-0.51, K-1.47, Ca-0.01, S-0.12, Mg-0.018, Zn-0.026, Fe-0.001, Mn-0.0003, Cu-0.00058, Mo-0.003 and B-trace + herbal etc. It also exhibits hormonal and enzymatic properties. Its doses are 1 ml in a liter of portable water

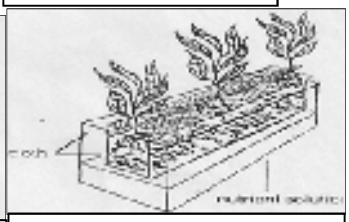


Low-tech culture

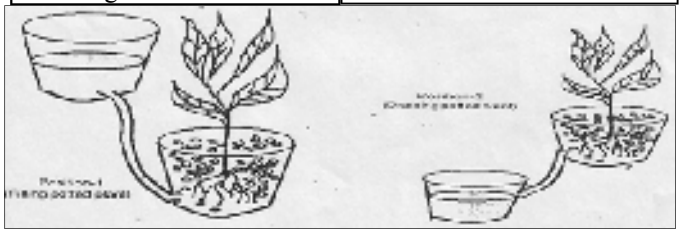


No Tech method

High-tech method



Tray method



EBB and Flow method

Idea/ research work conducted

Spend a few minutes daily for watering leaves, stems, flower and fruits of the plants being grown for any warming signs and always remember that love and care are vital.

If troubles appear, then a checklist should be prepared. The symptoms appearing may be due to light deficiency or fumes or over watering or due to sudden changes in temperature or over feeding or inadequate nutrition or due to infection of pathogens.

Experimental Design used

The method of 30 drops and 30 words was used.

Salient features and innovations

In Hydroponics the desired amount of food is directly available to the root. Further, pH and nutritional value of the water are easily measured plants have adequate nutritional matter available to absorb.

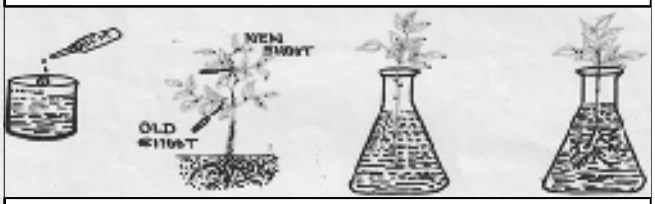
Hydroponics increases plant growth and yield per area, decreases pest diseases and need to water plants as against Geoponics, where plants grow slower, need more space and require constant maintenance. There is one added attraction in hydroponics, roots of the planted plants can be seen.

Use of technology

1. Non-arable land may be easily facilitated.
2. Non- degradable waste materials such as a pot may be used for the plant.
3. Year round greenery & crop production.
4. Using nutrient formulae to suit different plants at different stages.
5. Hydroponic plants are more pest resistant than Geoponic plants.
6. Hydroponics system opens up position for job training and employment.
7. It also satisfies consumer demands.

To convert waste into best

Different types of plant materials—Old shoots, new shoots, offshoot (banana), cactus, rhizome, bulb (gladiolus) respectively



Different stages of Hydroponics

Hydroponics at a glance—Waterculture, sandculture, gravelculture respectively

Conclusion

In the context of science for mankind and environment, the activities related to soilless culture are scientifically proven and the results are well known.

Keeping these and some other related issues in mind, the author has succeeded in conceiving, developing and giving them a practical shape. It is also called Alam Hydroponics method.

All the above described material & methods are globally desirable, socially acceptable, practically feasible economically viable and well tested.

About the author

Mohammad Jawaid Alam is the National Resource Person of Hydroponics and Master Resource Person of "Nature Study" and "Vermi Composting" of National council of Science and Technology Communication. He was one of the delegates at International Conference on Hands-on Science 2009. He can be reached at jawaidalampatna@yahoo.com.

Time to shoot!!

We are looking for some really mouth-watering photographs that might help us design the first cover pages of upcoming issues of NERD.

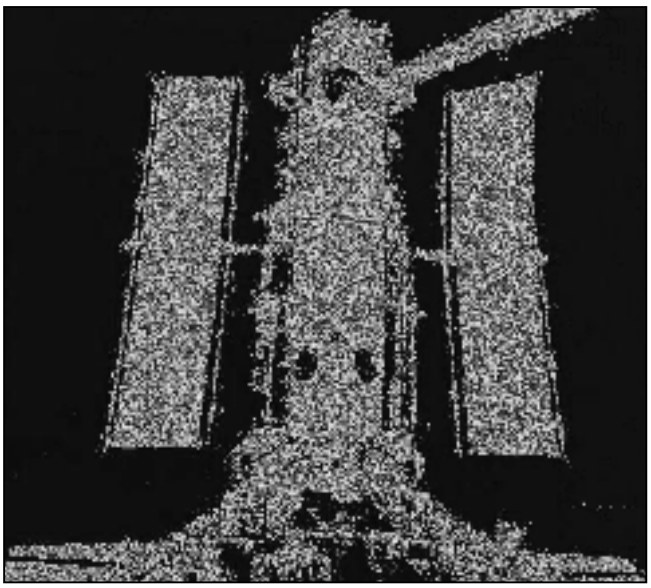
The photographs maybe a very beautiful image of a bird or a tree or anything picturesque in the campus. So come forwards and contribute by sending in the photographs latest by 30th June, 2010 at nerd@iitk.ac.in.

If the photograph is selected for the cover page, you will win a certificate of appreciation. We require atleast two photographs per issue. Please keep in mind that the photographs should be original and may be modified using softwares like Coral draw, and Adobe Photoshop.

Beyond the veil of universe

Hubble Telescope

Tej Pratap



Hubble's discoveries have transformed the way scientists look at the universe. Its ability to show the universe in unprecedented detail has turned astronomical conjectures into concrete certainties. It has winnowed down the collection of theories about the universe even as it sparked new ones, clarifying the path for future astronomers.

Among its many discoveries, Hubble has revealed the age of the universe to be about 13 to 14 billion years (more accurate than ever), dark energy (a mysterious force that causes the expansion of the universe to accelerate), galaxies in all stages of evolution, proto-planetary disks, clumps of gas and dust around young stars that likely function as birthing grounds for new planets. It also discovered that gamma-ray bursts — strange, incredibly powerful explosions of energy — occur in far-distant galaxies when massive stars collapse. Till date, more than 6,000 scientific articles have been published based on Hubble data.

How it works

Every 97 minutes, Hubble completes a spin around Earth, moving at the speed of about five miles per second. As it travels, Hubble's mirror captures light and directs it into its several scientific instruments.

Hubble is a type of telescope known as a Cassegrain reflector. Light hits the telescope's primary mirror. It bounces off the primary mirror and encounters a secondary mirror. The secondary mirror focuses the light through a hole in the center of the primary mirror that leads to the telescope's science instruments.

Hubble's primary mirror is 94.5 inches (2.4 m) in diameter. This mirror is small compared to those of current ground-based telescopes, which can be 400 inches (1,000 cm) and up, but Hubble's location beyond the atmosphere gives it remarkable clarity.

Once the mirror captures the light, Hubble's instruments work together or individually to provide the observation. Each instrument is designed to examine the universe in a different way. The Wide Field Camera 3 (WFC3) sees three different kinds of light: near-ultraviolet, visible and near-infrared, though not simultaneously. Its resolution and field of view are much greater than that of Hubble's other instruments. WFC3 is one of Hubble's two newest instruments, and will be used to study dark energy and dark matter, the formation of individual stars and the discovery of extremely remote galaxies previously beyond Hubble's vision.

The Cosmic Origins Spectrograph (COS), Hubble's other new instrument, is a spectrograph that sees exclusively in ultraviolet light. Spectrograph acts something like prisms, separating light from the cosmos into its component colors. This provides a wavelength "fingerprint" of the object being observed, which tells us about its temperature, chemical composition, density, and motion. COS will improve Hubble's ultraviolet sensitivity at least 10 times, and up to 70 times when observing extremely faint objects.

The Advanced Camera for Surveys (ACS) sees visible light, and is designed to study some of the earliest activity in the universe. ACS helps map the distribution of dark matter, detects the most distant objects in the universe, searches for massive planets, and studies the evolution of clusters of galaxies. ACS partially stopped working in 2007 due to an electrical

short, but was repaired during Servicing Mission 4 in May 2009.

The Space Telescope Imaging Spectrograph (STIS) is a spectrograph that sees ultraviolet, visible and near -infrared light, and is known for its ability to hunt black holes. While COS works best with small sources of light, such as stars or quasars, STIS can map out larger objects like galaxies. STIS stopped working due to a technical failure on August 3, 2004, but was also repaired during Servicing Mission 4.

The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) is Hubble's heat sensor. Its sensitivity to infrared light lets it observe objects hidden by interstellar dust, like stellar birth sites, and gaze into deepest space.

Finally, the Fine Guidance Sensors (FGS) are devices that lock onto "guide stars" and keep Hubble pointed in the right direction. They can be used to precisely measure the distance between stars, and their relative motions.

All of Hubble's functions are powered by sunlight. Hubble sports solar arrays that convert sunlight directly into electricity. Some of that electricity is stored in batteries that keep the telescope running when it's in Earth's shadow, blocked from the Sun's rays.

Hermann Oberth

First thought

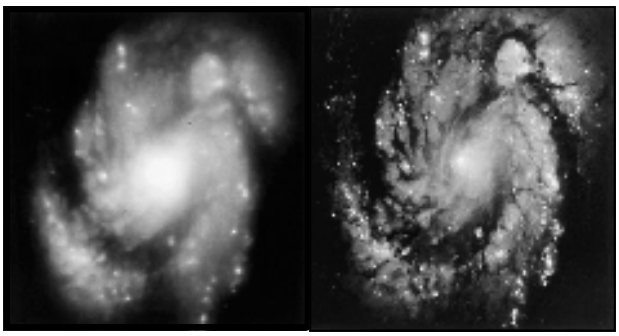
The idea for the space telescope arose in 1923, when German scientist Hermann Oberth, one of the founders of rocketry, suggested blasting a telescope into space aboard a rocket. In 1946, Lyman Spitzer Jr., an American astrophysicist, wrote a paper proposing a space observatory. He would spend the next 50 years working to make the space telescope a reality.

In 1975, the European Space Agency began to work together with NASA on a plan that would eventually become the Hubble Space Telescope. In 1977, Congress approved funding for the telescope.

Work begins

Shortly after Congress approved funding for the telescope, proposals for science instruments began to pour in. In 1981, the Space Telescope Science Institute was established in Baltimore, Md., to evaluate proposals for telescope time and manage the science program. The space telescope was named the Hubble Space Telescope, after American astronomer Edwin Hubble, who showed that the fuzzy patches of light in the night sky were actually other galaxies, far distant from our own, and went on to prove that the universe was expanding.

On April 24, 1990, Hubble launched into orbit aboard the Space Shuttle Discovery. The telescope carried five instruments: The Wide Field/Planetary Camera, the Goddard High Resolution Spectrograph, the Faint Object Camera, the Faint Object Spectrograph and the High Speed Photometer.



We have a problem!

Almost immediately after Hubble went into orbit, it became clear that something was wrong. While the pictures were clearer than those of ground-based telescopes, they weren't the pristine images promised. They were blurry.

Hubble's primary mirror, polished so carefully and lovingly over the course of a full year, had a flaw called "spherical aberration." It was just slightly the wrong shape, causing the light that bounced off the center of the mirror to focus in a different place than the light bouncing off the edge. The tiny flaw — about 1/50th the thickness of a sheet of paper - was enough to distort the view.

Scientists came up with a solution. A series of small mirrors could be used to intercept the light reflecting off the mirror, correct for the flaw, and bounce the light to the telescope's science instruments. The Corrective Optics Space Telescope Axial Replacement, or COSTAR, could be installed in place of one of the telescope's other instruments in order to correct the images produced by the remaining and future instruments. Astronauts would also replace the Wide Field/Planetary Camera with a new version,

the Wide Field and Planetary Camera 2 (WFPC2) that contained small mirrors to correct for the aberration. This was the first of Hubble's instruments to have building corrective optics.

Repair crew

On December 2, 1993, the Space Shuttle Endeavor carried a crew of seven into orbit for a mission that would involve five days of spacewalks and repairs. They removed the High Speed Photometer and replaced it with COSTAR. They replaced the original Wide Field/Planetary Camera with the newer WFPC2. They performed a host of other tasks, replacing solar panels, fuse plugs, and other hardware. By December 9, they were finished.

NASA released the first new images from Hubble's fixed optics on January 13, 1994. The pictures were beautiful; their resolution, excellent. Hubble was transformed into the telescope that had been originally promised.

Hubble would be successfully serviced and repaired several times afterwards. In February 1997, astronauts replaced the Goddard High Resolution Spectrograph and the Faint Object Spectrograph with improved instruments, the Near Infrared Camera and Multi-Object Spectrometer and the Space Telescope Imaging Spectrograph. In December 1999, they replaced a transmitter, all six gyroscopes, and one of three Fine Guidance Sensors, which allow fine pointing and keep Hubble stable during operations.

In February 2002, astronauts added the Advanced Camera for Surveys (ACS), the first new instrument to be installed in Hubble since 1997. ACS doubled Hubble's field of view, using a much more sensitive detector than WFPC2. Each time astronauts performed a servicing mission, they also performed routine repair work — fixing solar panels and thermal blankets, and upgrading equipment.

A last visit

Servicing Mission 4 took place in May 2009. Astronauts upgraded the telescope with the Wide Field Camera 3 and the Cosmic Origins Spectrograph, and repaired the Advanced Camera for Surveys and the Space Telescope Imaging Spectrograph. They replaced Hubble's batteries with new versions, and a Fine Guidance Sensor with a refurbished one; installed six new gyroscopes; and added new insulating panels to areas where Hubble's blankets had broken down. They replaced the Science Instrument Command and Data Handling unit (SIC&DH), which helps command the science instruments and control the flow of data within the telescope, and had suffered an electrical problem in 2008. Finally, they attached a ring-like structure that will allow a robotic module to connect itself to Hubble in the future; in order to guide the telescope through it's deorbit.

Astronauts headed back to Earth with a special piece of removed technology: COSTAR. All of Hubble's instruments since its initial launch have been designed with built-in corrections for the flawed mirror, eventually making COSTAR unnecessary.

Servicing Mission 4 is expected to extend Hubble's life into at least 2013. A rejuvenated telescope will continue to beam images of the heavens back to Earth, transferring about 120 gigabytes of data every week.

Hubble's successor, the James Webb Space Telescope (JWST), is currently in the works. JWST will study objects from the earliest universe, objects whose light has "redshifted," or stretched into infrared light.

References:
1. www.wikipedia.org
2. www.hubblesite.org

Sources of images:
1.http://static.howstuffworks.com/gif/hubble-deploy2a.jpg
2.http://www.nmspacemuseum.org/halloffame/images/large/oberth.jpg
3.http://en.wikipedia.org/wiki/File:Improvement_in_Hubble_images_after_SMM1.jpg

About the author

Tej Pratap (tpratap@iitk.ac.in) is a 2nd year undergraduate in the Department of Mechanical Engineering at IIT Kanpur.

Decide the main course!

Got ideas for articles? Want to read about something specific? Tell us about what you would like to read. Just mail your suggestions at nerd@iitk.ac.in and we will certainly accommodate all reasonable suggestions.

Fuelling the fuel cells

Fuel Cells

Anshumaan Bajpai and Pranjal Joshi

After decades of endless use of coal and other fossil fuels, sadly enough, we are now paying the price. The environment is getting polluted, global warming is increasing, and the ozone layer is depleting at an alarming rate.

In earlier times, we heavily relied on wood for all our energy needs. Deforestation became a regular phenomenon and we worried about planet earth. And then coal was discovered, an efficient alternative to wood which was later replaced by petroleum.

Then, we had thought that our energy needs have been taken care forever. Industrial revolution ensured that their usage spiked through the sky. However, after never-ending mining and drilling, we realized that there is a limitation to how much we can use them. Because one day, the mines will be empty and drilling pipes would dry out. Over the years, their demand has been far outstripping their availability. The world economy relies on a limited resource; and trends suggest that global energy use is expected to double in the coming decade. At the same time, concerns about the effects of anthropogenic carbon dioxide and criteria pollutants and energy security continue to mount. Meeting our energy needs in a sustainable manner is a challenge that will cause us to diverge from the pattern of the last couple of centuries.

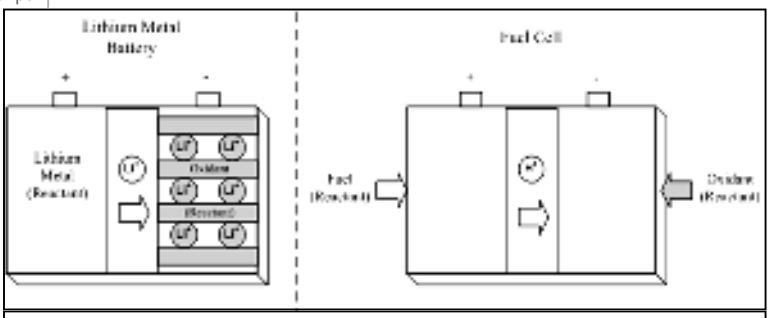
It is essential to understand the term 'alternative energy' for realizing the importance of alternative forms of energy. The term 'alternative energy' implies energy that is used as an alternative to fossil fuels. Dictionary defines 'alternative energy' as 'solar, wind, or other renewable energy, that can replace or supplement traditional fossil-fuel resources such as coal, oil, and natural gas.' Though nuclear energy is also a safe energy form, it is often not included in the 'alternative energy' category because of its feared radioactive waste.

Wind, water and sun are never ending source of energy. However, the biggest advantage of using them is that they don't harm environment in any way. Importance of alternative energy thus becomes paramount. We have already enjoyed benefits of using water energy. Hydro-electricity is increasingly being used throughout the world.

Storage and conversion of energy become increasingly relevant as we move towards greater reliance on renewable or non-traditional energy sources. Most of the alternative energy sources are location specific. For instance solar energy can be used only where there is good exposure to sunlight. Similarly, hydro-electricity can be generated where there is ample amount of flowing water, and so on. Fuel cells and batteries are therefore expected to be an important energy technology for the future.

Fuel cells are an efficient means to convert chemical energy into electrical energy with little or no emissions. Fuel cells are different from conventional electrochemical cell batteries in the way that they consume reactant from an external source, which must be replenished – a thermodynamically open system. By contrast, batteries store electrical energy chemically and hence represent a thermodynamically closed system.

Both are electrochemical devices that produce energy directly from an electrochemical reaction between the fuel and the oxidant. The battery is an energy storage device. The maximum energy available is determined by the amount of chemical reactant stored in the battery itself. A battery has the fuel and oxidant reactants built into itself (onboard storage), in addition to being an energy conversion device. In a secondary battery, recharging regenerates the reactants. This involves putting energy into the battery from an external source. The fuel cell is an energy conversion device that theoretically has the capability of producing electrical energy for as long as the fuel and oxidant are supplied to the electrodes.



Comparison of a fuel cell and a battery

The lifetime of a primary battery is limited because when the amount of chemical reactants stored in a battery runs out, the battery stops producing electricity. In addition, when a battery is not being used, a very slow electrochemical reaction takes place that limits the lifetime of the battery. The electrode of a battery is also used in the process; therefore, the lifetime of the battery is dependent on the lifetime of the electrode.

In comparison, a fuel cell is an energy conversion device where the reactants are supplied. The fuels are stored outside the fuel cell. A fuel cell can supply electrical energy as long as fuel and oxidant are supplied. The amount of energy that can be produced is theoretically unlimited as long as the fuel and oxidant are supplied. Also, no "leakage" occurs in a fuel cell, and no corrosion of cell components occurs when the system is not in use.

A fuel cell generates electrical power by continuously converting the chemical energy of a fuel into electrical energy through an electrochemical reaction. The fuel cell itself has no moving parts, making it a quiet and reliable source of power. Fuel cells typically utilize hydrogen as the fuel, and oxygen (usually from air) as the oxidant in the electrochemical reaction. Other fuels include hydrocarbons and alcohols. Other oxidants include chlorine and chlorine dioxide. The reaction results in electricity and by-products water and heat.

When hydrogen gas is introduced into the system, the catalyst surface of the membrane splits hydrogen gas molecules into protons and electrons. The protons pass through the membrane to react with oxygen in the air (forming water). The electrons, which cannot pass through the membrane, must travel around it, thus creating the source of DC electricity.

There are nine different types of fuel cells for different purposes. They are: phosphoric acid, molten carbonate (MCFC), solid oxide (SOFC), alkaline, direct methanol fuel cells (DMFC), regenerative fuel cells, zinc-air fuel cells (ZAFC), protonic ceramic fuel cells (PCFC), and the proton exchange membrane (PEM) fuel cell. They all differ in application, operating temperature, cost and efficiency.

Because the fuel is converted directly into electricity, a fuel cell can operate at much higher efficiencies han internal combustion engines, extracting more electricity from the same amount of fuel.

In case of an IC engine the maximum amount of heat that may be converted to useful work is limited by Carnot's efficiency $(1- (T_L/T_H))$. In most of the cases the difference between T_L and T_H isn't large enough to allow efficiency to go beyond 25%. On the other hand a fuel cell directly converts the available chemical energy into work in the form of electricity and therefore isn't susceptible to Carnot's limit.

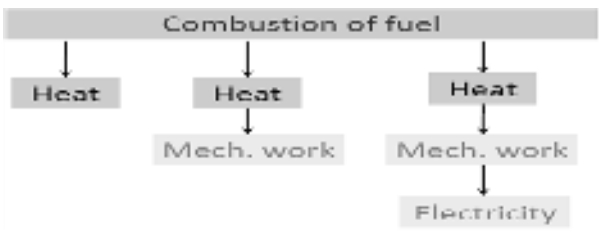
There are many kinds of fuel cell which are most commonly classified on the basis of their operating temperature.

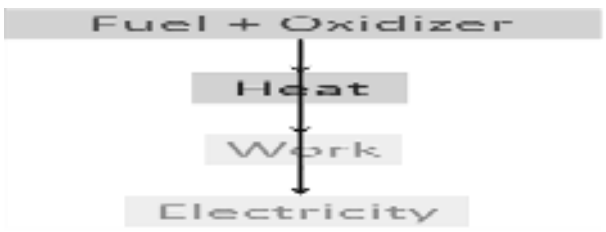
SOFC and PEMFC are two of the more popular fuel cells in terms of research in the contemporary world. While PEMFC operates in the temperature range 50^0C – 100^0C, a SOFC typically operates between 500^0C -1000^0C.

In a PEMFC, hydrogen in used as a fuel which is supplied to the anode of the cell where it undergoes dissociation as follows:

$2H_2 => 4H^+ + 4e^-$

The newly formed protons permeate through the polymer electrolyte membrane to the cathode side. The electrons travel along an external load circuit to the cathode side of the membrane electrolyte assembly (MEA), thus creating the current output of the fuel cell.





Meanwhile, a stream of oxygen is delivered to the cathode side of the MEA. At the cathode side oxygen molecules react with the protons permeating through the polymer electrolyte membrane and the electrons arriving through the external circuit to form water molecules. This reduction half-cell reaction is represented by:

$O_2 + 4H^+ + 4e^- \Rightarrow 2\ H_2O$

The electrolyte membrane plays the most crucial role in this system as it has to be strictly specific in function. It should have high proton conductivity and at the same time should be non-permeable to the electrons formed during the dissociation as that would result in short circuiting of the fuel cell. The membrane must also not allow either gas to pass to the other side of the cell, a problem known as gas crossover. Finally, the membrane must be resistant to the reducing environment at the cathode as well as the harsh oxidative environment at the anode.

The most commonly used membrane is Nafion by DuPont, which relies on liquid water humidification of the membrane to transport protons. This implies that it is not feasible to use temperatures above 80–90 °C, since the membrane would dry up. Other, more recent membrane types, based on Polybenzimidazole (PBI) or phosphoric acid, can reach up to 220 °C without using any water management: higher temperature allows for better efficiencies, power densities, ease of cooling (because of larger allowable temperature differences), reduced sensitivities to carbon monoxide poisoning and better controllability (because of absence of water management issues in the membrane); however, these recent types are not as common.

Splitting of the hydrogen molecule is relatively easy by using a platinum catalyst. Unfortunately however, splitting the oxygen molecule is more difficult, and this causes significant electric losses. An appropriate catalyst material for this process has not been discovered, and platinum is the best option. Much of the current research on catalysts for PEM fuel cells can be classified as having one of two main objectives:

1) To obtain higher catalytic activity than the standard carbon-supported platinum particle catalysts used in current PEM fuel cells or,
2) To reduce the poisoning of PEM fuel cell catalysts by impurity gases.

Unlike PEMFC, the SOFCs use the solid oxide electrolyte to conduct negative oxygen ions from the cathode to the anode. The electrochemical reaction of the oxygen ions with hydrogen or carbon monoxide thus occurs on the anode side. The superiority of this class of fuel cell lies in high efficiencies, long term stability, fuel flexibility, low emissions and cost. The biggest disadvantage is the high operating temperature which results in longer start up times and mechanical/chemical compatibility issues.

The most common material used for the electrolyte is a cermet made up of nickel mixed with the ceramic material in that particular cell, typically YSZ (Yttria stabilized Zirconia). The oxidation reaction between the oxygen ions and the hydrogen at anode electrolyte interface produces heat as well as water and electricity. If the fuel is a hydrocarbon, for example methane, another function of the anode is to act as a catalyst for steam reforming the fuel into hydrogen. The reaction occurring at anode is:

$2\ H_2 + 2\ O^{2-} \Rightarrow 2\ H_2O + 4\ e^-$

Cathode materials must be, at minimum, electronically conductive. Currently, lanthanum strontium manganite (LSM) is the cathode material of choice for commercial use because of its compatibility with doped zirconia electrolytes and its ability to dissoci-

	Low-temperature Fuel Cells			High-temperature Fuel Cells		
	DMFC Direct methanol fuel cell	**PEMFC** Proton exchange	**AFC** Alkaline fuel cell	**PAFC** Phosphoric acid fuel cell	**MCFC** Molten carbon fuel	**SOFC** Solid oxide fuel
Electrolyte	Proton-conducting membrane	Proton-conducting membrane	Caustic potash solution	Concentrated phosphoric acid	Molten carbonate	Ceramic
Temperature range	< 100° C	< 100° C	< 100° C	– 200° C	– 650° C	800 - 1,000
Fuel	Methanol	Hydrogen	Hydrogen	Hydrogen	Natural gas, coal	Natural gas, coal
Power ranges	Watts/ kilowatts	Watts/ kilowatts	Watts/ kilowatts	Kilowatt	Kilowatts/ megawatts	Kilowatts/ megawatts
Application areas (examples)	Vehicles, small appliances	Vehicles, small generators, domestic supply, block-type heat and power stations	Space	Block-type heat and power stations	Power plants, combined heat and power	Power plants, combined heat and power

ate oxygen as follows:

$O_2 + 4\ e^- \Rightarrow 2\ O^{2-}$

Research is going now in the direction of lower-temperature SOFC (600°C) in order to decrease the materials cost, which will enable the use of metallic materials with better mechanical properties and thermal conductivity. The other area of research is to improve the fuel flexibility of SOFCs. Since the cell operates at very high temperatures, it produces large amount of heat. Attempts are being made to integrate the SOFC unit with an external hydrocarbon reforming unit such that the heat is efficiently utilized and the overall efficiency of the process is significantly improved.

As a part of my thesis I am fabricating a SOFC based on conventional methods and developing hybrid polymer membranes with high oxygen conductivity even at low temperature. The hybrid cathodes are being developed by impregnating the conventional cathode material with polymeric materials like polyaniline, polyacrilonitrile and so on. We are also developing a novel proton exchange membrane using polybenzimidazole as base and the results so far have been encouraging.

About the authors

Anshumaan Bajpai (anshub@iitk.ac.in) is a fifth year dual degree student in the department of chemical engineering and pursuing thesis under Dr. Raj Pala with Dr. Anil Kumar as co-guide. His research interests include fabricating high temperature fuel cells and simulation of fuel cells using design software like AspenTech and Hysys.

Pranjal Joshi (pjoshi@iitk.ac.in) is research assistant under Dr. Anil Kumar and has recently completed his M. Tech program from the department of chemical engineering. His research interests include development of alternatives to proton exchange membrane.

References:

http://www.benefits-of-recycling.com/importanceofalternativeenergy.html
http://en.wikipedia.org/wiki/SOFC
http://en.wikipedia.org/wiki/Proton_exchange_membrane_fuel_cell
http://www.fctec.com/fctec_basics.asp

Redesigning the distribution

Modelling Facility Location on Supply Chain Networks

Dr. R.R.K. Sharma and Priyanka Modi

Introduction

A typical supply chain functions optimally by meeting the criteria of cost, delivery and inventory locked up in the system in a most favorable manner. Designing a distribution system, which is very much an integral part of the supply chain, is a strategic issue for the companies. This decision is taken in two steps; in the first step a facility and its location is chosen, while the customers are assigned to this facility in the second step. Therefore, locating a facilities and allocating customers over it, is the core topic of distribution systems design. Food Corporation of India (FCI), the Indian government agency involved in distributing food grains across the country, annually spends over INR 30,000 crores on distribution and warehousing. Sharma (1996) has reported a problem encountered by FCI, which is closer to multistage un-capacitated warehouse location problem

Facility location is basically a process of identifying the best geographic location for a service or production facility, in terms of economy and comfort. Commercially, facility location refers to locating a facility such that, best possible service can be provided by the facility to the customers, incurring the minimum cost. The decision process involves selection of the facilities and their location in order to satisfy the originated demands. Drivers for the decision of facility location are issues like – cost reduction, demand capture, equitable service supply, fast response time etc. In past approaches taken-up by the students of IME Department at IIT Kanpur, which has been briefed in this article, essentially the cost has been considered as an overriding objective.

Types of facilities

The various types of facilities involved in a typical supply chain may include warehouses, retail outlets, communication concentrators, etc. Broadly, they can be categorized as follows:

Mining, quarrying and heavy manufacturing
Factors to be taken care of for these spacious and expensive facilities includes its construction costs, land costs, raw material and finished goods shipment modes, proximity to raw materials, utilities, and labor availability.

Light manufacturing
Factors to be considered for such comparatively smaller, cheaper and cleaner facilities are transportation costs, proximity to markets, frequency of delivery required by customer, land costs, easily accessible geographic region, education and training capabilities.

Warehouse
Such facilities require proximity to transportation facilities. Because of appropriate incoming and outgoing costs of transportation, it results in a reduced overall cost. A proper location results in responsiveness of trade agreements.

R&D and high tech manufacturing
Location of such facilities must possess an attractiveness and ability to recruit/retain scientists and engineers. Its location should be near to companies with similar technological interests.

Retailing and for profit services
These are smallest and probably the cheapest facilities. The main issue is its proximity to the customers.

Government and health emergency services
These facilities are also required to be near concentrations of constituents, so as to be reachable to the maximum population.

Modelling the problem
Location decisions involve various fixed and variable costs, which are required to be minimized. Fixed costs may be in form of facility construction/ rental cost, vehicle purchases and rentals cost, personnel payment cost, fixed overhead cost. Variable Costs involve inventory cost, handling cost, fuel cost, etc.

Model formulations and solution algorithms which address the issue varies widely in terms of fundamental assumptions, mathematical complexity and computational performance. Many researchers have worked on the problem of locating facilities, viz. plants and warehouses, on a network so as to minimize the sum of distribution and location costs. Modeling these problems invariably results in a mixed 0-1 integer linear program.

The basic problems: SPLP and CPLP
The most basic version of the facility location problem is called Simple Plant Location Problem (SPLP), in which plants of unlimited capacity directly supply goods to the markets. Modeling this problem has an important dimension, the concept of 'strong' and 'weak' formulation. Strong formulation gives better bounds of the linear programming relaxation of the mixed 0-1 integer linear program that results in faster convergence of the branch and bound based approach used for its solution. This concept was extended to the next basic version of the problem called the Capacitated Plant Location Problem (CPLP) in which plants of limited capacity supply good directly to markets. Sharma and Muralidhar cast the existing 'strong' and 'weak' formulations of SPLP in a new style, useful to multistage warehouse location problems. Figure 1 shows a diagrammatic view of the problem.

CPLP formulation
To give a feel of formulating a plant location problem, we present here the formulation of CPLP as a mixed integer problem (MIP). This is conventional formulation of the problem.
Objective:

$$(1)\ \text{Z=Min}\ \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij} + \sum_{j=1}^{n} f_j y_j$$

Subject to:

$$(2)\quad \sum_{j=1}^{n} x_{ij} = 1 \qquad \forall i$$

$$(3)\quad \sum_{i=1}^{m} D_i x_{ij} \le CAP_j y_j \qquad \forall j$$

$$(4)\quad x_{ij} \le y_j \qquad \forall i$$

$$(5)\quad x_{ij} \ge 0 \qquad \forall i, j$$

$$(6)\quad y_j = 0,1 \qquad \forall j$$

$$(7)\quad \sum_{j=1}^{n} CAP_j y_j \ge \sum_{i=1}^{m} D_i$$

The various constants, variables and index used to formulate CPLP are described as follows:

i : 1,...,m ; set of customers

j : 1,...,n; set of potential locations

Definition of Constants:

c_{ij} : Total cost of transportation from plant 'j' to customer 'i'.

D_j : Demand of customer 'i'.

CAP_j : Capacity of plant 'j'.

f_i : Fixed cost associated with plant 'j'.

Definition of Variables:

x_{ij} : Fraction of demand of customer 'i' supplied from plant 'j'.

y_j : 0, 1 indicating whether plant is closed or open.

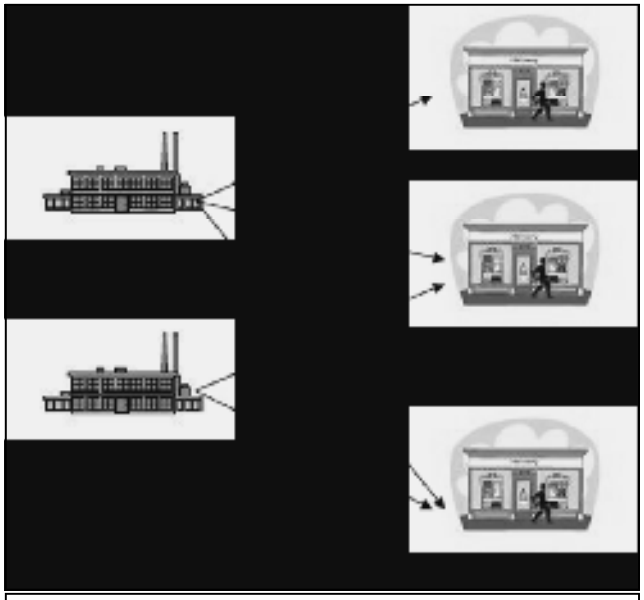


Figure 1: Simple/Capacitated Plant Location Problem (SPLP/CPLP)

Earlier approaches for warehouse location problem

Warehouse location problems are classified under the genre of facility location problems, where perceptibly the facility is a warehouse. Warehouses are located between the producer (plants) and the consumer (markets). These problems are extensions of SPLP and CPLP depending on capacity limitations.

Single and Multistage warehouse location problems are difficult to model as they involve location of a facility (warehouse) in between plant and market. Another difficulty is to develop strong constraints for these problems. Strong constraints make a formulation strong by adding such constraints which provide better bounds to a problem; this ultimately is helpful in attaining better solution time. First rationalized formulation of SSCWLP (Single Stage Capacitated Warehouse Location Problem), which was given by Sharma (1996), had a scope of writing 'strong' constraints of SSCWLP, however their formulation was actually 'weak'. This idea of developing 'strong' constraints to SSCWLP was later discovered by Sharma and Berry (2007). They developed strong 'supply', 'demand' and 'capacity' constraints for the SSCWLP. This was empirically verified its efficacy. In light of work done by Sharma and Berry (2007) it can be easily concluded that Geoffrion and Graves (1974), Sharma (1991) and Sharma (1996) used 'weak' formulation of SSCWLP.

Another important aspect of modeling attempted by us is explained as follows. Our research mainly focuses on deriving a method to solve single/two stage warehouse location problems. Geoffrion and Graves (1974) used flow variables as x_{ijk}, i.e. flow from plant 'i' to warehouse 'j' to market 'k'. But Sharma (1991) used x_{ij} and y_{jk} as flow variables, where x_{ij} denotes flow from plant 'i' to warehouse 'j' and y_{jk} denotes flow from warehouse 'j' to market 'k'. This style of formulation results in greatly reduced number of variables and it was expected that mathematical model of Sharma (1991) will take significantly less amount of computer time for obtaining the optimal solution. This was later verified by Sharma and Berry (2007).

Variation is conceptualized in a realistic manner by varying the capacity considerations of the warehouses; as well as by changing the warehouse echelons. It is clearer from figure 2. Solution approaches for diverse single and multistage facility location problems are evaluated which are highlighted in the next sections.

Single stage un-capacitated warehouse location problem (SSUWLP)

SSUWLP arises when the distances between plants and markets are quite large and it becomes necessary to route the supplies through warehouses, also known as transshipment points. The set of potential trans-shipment locations are known, with each point having an associated fixed cost with it. The problem is to choose a sufficient number of trans-shipment points (warehouses) such that the sum total of fixed location cost and transportation costs of shipping commodity from plants to warehouse and then from warehouse to markets is minimized. In addition to the assumption of unlimited capacity of warehouses, consideration of single commodity is presumed in the model. 'Strong' and 'Weak' formulations of

SSUWLP are developed.

'Strong' formulations of SSUWLP are developed by adding demand and/or supply constraints to the 'weak' formulation. Linear programming (LP) relaxations of these 'strong' and 'weak' formulations were developed by relaxing the binary constraints in the formulation (Verma and Sharma, 2010). Later, theoretical proofs are given which shows the strength of one LP relaxation over the others. It is found that even though the 'strong' formulations give better bounds, it is unable to solve large sized SSUWLP more efficiently in terms of CPU time. In order to overcome this, most promising demand and/or supply constraints are added to the 'weak' formulation which leads to different 'hybrid' formulations of SSUWLP. These hybrid formulations were seen to solve the original problem instances of SSUWLP in significantly less CPU time when compared to 'weak' formulation of SSUWLP. This work has been done by Verma and Sharma (2007a).

Single stage capacitated warehouse location problem (SSCWLP)

Again, the goods are shipped from plants to markets through warehouses. But the difference of SSCWLP from the earlier version (SSUWLP) is that the warehouses are of limited capacity. The objective is to minimize the sum of warehouse location costs and transportation costs. This work also considers a case of single commodity flow.

A new formulation of SSCWLP is developed in this work. Verma and Sharma (2007b) have used the formulation style of Sharma and Sharma (2000) to formulate SSCWLP as suggested by Sharma (1991). The approach for SSCWLP in this part is to decompose the problem vertically to get smaller sized problems. The "vertical decomposition" approach for SSCWLP allows relaxing the flow balance constraints and getting two versions of CPLP. This is referred to by the authors as RHS_CPLP and LHS_CPLP. RHS_CPLP is exactly identical to the traditional CPLP and is well researched in literature. Various LP relaxations and Lagrangian Relaxations (LR) of these two decomposed problems are developed. Relative strengths of different relaxations of CPLP are available in literature [Sridharan (1986)], which almost directly caters to our RHS_CPLP. The other problem is LHS_CPLP which is actually different from RHS_CPLP; but some results of RHS_CPLP are applicable to LHS_CPLP as well. Finally, these relaxations are extended to SSCWLP and comparison of relative strengths of different relaxations is done. Verma and Sharma (2007b) shows that there are 13 relaxations of SSCWLP; and give the relative strengths of these relaxations. Computational experiences of the 13 different relaxations are analyzed by Verma and Sharma (2009) to find that there exist better relaxations of SSCWLP than the strongest LP relaxation proposed by Sharma and Berry (2007). Computational experiences for the overall SSCWLP and its relaxations are being gained by the authors.

Two stage capacitated warehouse location problems (TSCWLP)

TSCWLP is having two echelons of warehouses in between supply points and markets. These warehouses are of limited capacity. Assumption is made that single commodity is transported in between the stages. The objective is to minimize the sum of warehouse location costs and transportation costs in between the stages.

TCSWLP, as such, is a very big and complex problem to solve. Hence the vertical decomposition approach, which was originally used for SSCWLP, is applied for TSCWLP too, so-as-to get smaller problems which can be solved efficiently. Vertical decomposition is applied here too by relaxing the associated flow balance constraints. This leads to three different versions of CPLP referred to as RHS_CPLP, MID_CPLP and LHS_CPLP in this work. LHS_CPLP is itself different than RHS_CPLP (as considered by Sridharan

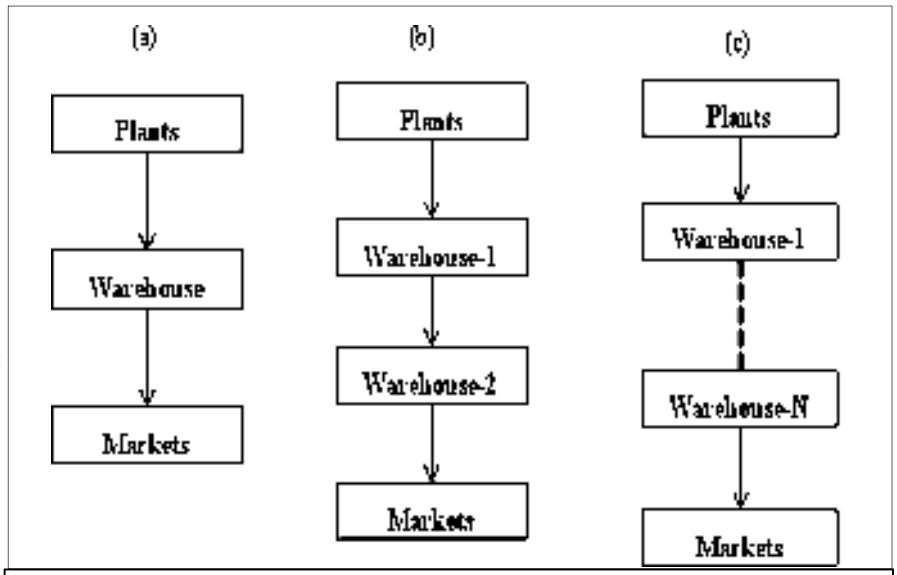


Figure 2: Multistage Facility Location Problems

(1986)); however MID_CPLP is an entirely new kind of problem. For these sub-problems a variety of LP relaxations and Lagrangian relaxations are developed.

Theoretical proofs are developed to compare the strength of different relaxations. Later a procedure is developed for solving complete TSCWLP by integrating LHS_CPLP, MID_CPLP and RHS_CPLP. The best-bounds provided by the relaxations of the decomposed problem are used as lower bound for solving TSCWLP in a branch and bound procedure. The computational experiences of a variety of problems for all these relaxations are reported by Verma and Sharma (2008).

References

1. Geoffrion, A.M. and Graves G. W., (1974), Multicommodity distribution system design by Benders decomposition. Management Science, 2, 82-114.

*2. Sharma, R.R.K., (1991), Modeling a fertilizer distribution system. European Journal of Operational Research, **51**, 24–34.*

3. Sharma, R.R.K., (1996), "Food grains distribution in the Indian context: An operational study", in "Operations Research for Development", Ahmedabad, India; Chapter 5, Eds. Prof. A. Tripathy and Prof. J. Rosenhead, New Age International Publishers, New Delhi, pp. 212-227. ISBN 81-224-1016-2.

*4. Sharma, R.R.K. and Berry, V., (2007), Developing new formulations and relaxations of single stage capacitated warehouse location problem (SSCWLP): Empirical investigation for assessing relative strengths and computational effort. European Journal of Operational Research, **177**(2), 803-812.*

5. Sharma, R.R.K. and Muralidhar, A., A new formulation and relaxation of the simple plant location problem, Asia Pacific Journal of Operational Research, (accepted, to appear).

*6. Sharma, R.R.K. and Sharma, K.D., (2000), A new dual based procedure for the transportation problem. European Journal of Operational Research, **122** (3), 96–109.*

7. Sridharan, R., (1986), Capacitated Plant Location Problem. Unpublished Ph.D. dissertation, Carnegie Mellon University.

8. Verma, Priyanka., and Sharma, R.R.K., (2007a), Different Formulations of the Single Stage Uncapacitated Warehouse Location Problem: A Few Theoretical and Empirical Results, (Under review in European Journal of Operational Research, Discrete Optimization).

9. Verma, Priyanka., and Sharma, R.R.K., (2007b), Vertical Decomposition Approach To Solve Single Stage Capacitated Warehouse Location Problems, P r o - ceedings of the IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), pp. 907-911, 2-5 Dec. 2007, Singapore; ISBN-10: 1424415292.

10. Verma, Priyanka., and Sharma, R.R.K., (2008), Two Stage Capacitated Warehouse Location Problem: Conceptual Scheme of the Vertical Decomposition Approach, Proceedings of the Fourth International Conference on Logistics and Supply Chain Management, Aug 7-9, 2008, Organized by Centre of Supply Chain Management, PSG College of Technology Coimbatore and Central Michigan University, Mt. Pleasant, MI 48859, USA.

11. Verma, Priyanka., and Sharma, R.R.K., (2009), Relaxations of the Decomposed Single Stage Capacitated Warehouse Location Problem: Empirical Comparisons, Proceedings of the 2nd International conference on Decision Sciences in Global Enterprise Management; IIT Bombay, India; pp. 526-538, 03-05 January 2009; ISBN: 10:0230-63725-6.

12. Verma, Priyanka., and Sharma, R.R.K., (2010), Strong and weak formulations of Single Stage Uncapacitated Warehouse Location Problem, Springer Lecture Notes in Computer Science – Communications in Computer and Information Science, LNCS-CCIS. (Accepted)

About the authors

Professor RRK Sharma (rrks@iitk.ac.in), IME Department, IIT Kanpur. Dr Sharma is PhD in Management from IIM Ahmedabad. With around 20 years of teaching and research experience at IME Department, IIT Kanpur, he has taught a number of management courses. He has authored more than 70 papers in international/national journals, reputed conference proceedings and a book on MRP systems. Apart from supply chain optimization and MRP systems, he has research interests in manufacturing strategy, strategic management, ERP systems and information & control systems.

Priyanka Modi (pmodi@iitk.ac.in), Doctoral Student, IME Department, IIT Kanpur. Priyanka Modi is working for her doctoral thesis under Prof RRK Sharma. Basically a Mechanical Engineer, she has done MTech from IME, IIT Kanpur. Her area of interest is operations research, optimization, operation management, supply chain management and Logistics. She has published over 5 articles in International Journals and reputed Conference Proceedings.

The Emerging Biofuel
Biobutanol

Prashant Varshney

The world saw unprecedented growth in personal mobility during 20th century. The internal combustion engine fuelled with gasoline and diesel played a central role. But while society value the benefits of increased mobility, the use of oil as the primary transport fuel poses a range of sustainability challenges. Besides dwindling reserves, widespread use of crude oil has resulted in emission of regulated and unregulated pollutants, leading to various environmental, physical and sustainability problems. Questions of energy supply security, local emissions and green house gas emissions, all need to be balanced against the desire of a growing global population to have access to affordable and efficient energy availability. Biobutanol may be the Holy Grail in alternative fuel systems. What is Biobutanol and why does it have the potential to revolutionize the alternative fuel industry?

Biobutanol is cousin to green-fuel family member bioethanol. The difference between bioethanol and biobutanol is that bioethanol has 2 carbons in its backbone while biobutanol has 4 carbons. Biobutanol originates from biomass or organic matter as opposed to petrobutanol which originates from petroleum. The reason biobutanol is hailed to have tremendous potential in helping end our world energy crisis is the fact that certain bacteria, particularly strains of clostridium have the unique ability to digest all types of organic matter into a mixture of acetone, butanol, and ethanol. In recent years, some patented processes (e.g. Butyl Fuel, LLC) have been able to synthesize biobutanol in larger amounts very effectively through the utilization of a strain of clostridium bacteria known as clostridium tyrobutyricum. The process involved in the production of butanol from biomass is quite similar to that of ethanol, essentially consisting of bacteria or other microorganisms breaking down a solution of sugar, starch, lignin, or fibre into a mixture of chemicals including butanol. The butanol, being only slightly soluble in water is then separated from the solution either by an adsorbent or through distillation.

So why is biobutanol particularly useful? It has an energy density (just 10% less than gasoline) closer to gasoline than ethanol (30% less than gasoline). It also mimics gasoline in its burning properties when utilized in a gasoline motor. Along with these exciting attributes is the fact that in more than one test on older vehicles, butanol was safe to use at 100% concentration. David E. Ramey (Environmental scientist and Founder and President of Environmental energy, Inc (EEI)) drove his 1992 Buick running on biobutanol from Bleaklick to Brookings (USA) in 2005 without any problem and moreover with improved torque properties and mileage compared to gasoline. His Buick averages 22 miles per gallon (mpg) with gasoline, whereas it averaged 25 mpg on 100% biobutanol. This result pertained without modification to the engine, whereas modifications are required for automobiles to use E85 (85% ethanol, 15% gasoline). Biobutanol has the potential to replace gasoline, gallon for gallon. It also is not very hygroscopic, so it does not require the different handling that ethanol requires due to it water loving properties. Butanol also works at a wider range of temperature than ethanol and has excellent cold start properties. This means that a gasoline engine running on butanol on a cold winter morning will not have any problems starting. In addition to this, butanol can be produced cheaper than fossil fuels, reduces vehicular emissions, and does not attack the materials commonly used in internal combustion engines. It is combustible, but not dangerously flammable as is gasoline and ethanol. It can be shipped through existing oil pipelines without causing damage.

Biobutanol may be the most realistic replacement for gasoline the search for alternative fuels has produced as of yet. When biobutanol is produced from organic substance, it has a neutral CO_2 balance. This means that the net amount of carbon dioxide emitted into the atmosphere as a result of the consumption of butanol is zero. This is possible because of the fact that the plants which are used to make butanol themselves absorb carbon dioxide from the atmosphere as they grow. Reduction in CO_2 emissions can also solve the global warming problems. This may be the most important consideration in replacing gasoline with biobutanol because of the detrimental effects this centuries consumption of fossil fuels has had on our environment. Continuous research is going on to develop more effective means of converting biomass into biobutanol and its

simultaneous recovery so that this promising fuel can acquire its position in the category of alternative fuels which it deserves. Biobutanol may be the gasoline of tomorrow. Thus, there is tremendous potential for future development that awaits elucidation and exploitation.

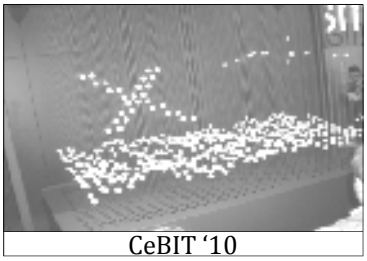
About the author
Prashant Varshney is a student in the Department of Petroleum Studies at ZHCET, Aligarh Muslim University. He can be reached at varshney2p@yahoo.co.in.

Just a second

Cloud Computing

Malik Rafi

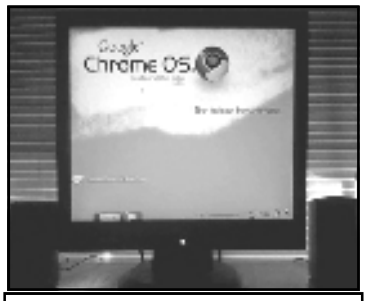
Imagine handling tens of trillions of computations in just one click. We're not talking about the latest super computer here but the one you use at home.



CeBIT '10

That's how fast your personal computer can get if companies like Google, Microsoft and IBM have their way. Cloud computing, the buzz word in the IT world is here to stay. The processing power of hundreds of servers and the reach of the internet can transform the way we look at our PC forever.

Supercomputers today are used mainly by the military, government intelligence agencies, universities and research labs, and large companies to tackle enormously complex calculations for such tasks as simulating nuclear explosions, predicting climate change, designing airplanes, and analyzing which proteins in the body are likely to bind with potential new drugs. Cloud computing aims to apply that kind of power—measured in the tens of trillions of computations per second—to solve problems like analyzing risk in financial portfolios, delivering personalized medical information, even powering immersive computer games, in a way that users can tap through the Web. It does that by networking large groups of servers that often use low-cost consumer PC technology, with specialized connections to spread data-processing chores across them. By contrast, the newest and most powerful desktop PCs process only about 3 billion computations a second.



SCREENSHORT OF CHROME OS

The term cloud computing refers to the storage, retrieval and processing of data on Data Centres or large servers that host these applications. It's a metaphor for harnessing computing power from locations that are far off from the user, from a cloud, in a manner of speaking. The idea of the cloud dates back to the 1990s when SaaS (Software as a service) applications were introduced by start-ups such as Salesforce.com and America Online.

Google, which uses the power of a large number of computers or Data Centres that IBM houses to churn out results for its search engine is a prime example of the immense potential of cloud computing.

The Google cloud as it is better known as spearheading, along with software and computing giants Microsoft and IBM, the cloud computing revolution . "Google is so fast because more than one computer is working on your query. It farms out your question, if you will, to on the order of 25 computers. It says, "You guys look over here for some answers, you guys look over here for some answers." And then the answers come back very quickly. It then organizes it to a single answer. You can't tell which computer gave you the answer. " says Eric Schmidt, Google's CEO.

Google's engineers use the computing power of a global network of its Data Centres to scan through a huge amount of data in no time, and voila, the results show up. It represents a new breed of supercomputers that mine through data at lightning speed. The company is spending billions of dollars to take out this technology it has excelled in for many years to the masses. To further its cause Google is making hundreds of its processors available to MIT, Stanford University and the likes to help teach high-performance computing

applications.

IBM or the Big Blue as it is called has opened four new Data Centres in India alone to cater to the computing needs of its clients who are willing to adopt this technology.

Amazon is another major player in the Cloud Technology and has been using its Cloud based services for quite some time now. It provides services through Amazon AWS (a web service interface).

Microsoft Azure, a .net based platform provides application services and has lent support to Infosys in setting up its own cloud based solution.

Gmail is an example of a web based service that relies on the Cloud technology for its speed and data processing. If you wondered why Gmail was quicker than the rest, here's the answer. Google also has a smart collection of web based applications called Google Apps.

Google, Amazon and Microsoft together own 20% of the world's servers. So count on them to make a huge impact on the cloud computing segment.

So what's in it for me?
Well, for starters you have much greater processing speeds at costs much less than what it would cost you today with the hardware. Cloud computing is all about taking supercomputing to the masses. Companies are adopting it big time for various reasons like scalability, cost-effectiveness, lesser or no maintenance cost of hardware. That means a company which has to run hundreds of servers or say even one doesn't even need to bother about its hardware anymore. All they might need is a computer connected to the cloud that it occupies. Why buy a car when you can do better with a cab? The servers are maintained by service providers like Google, IBM, and Amazon etc. That brings down the hardware costs to almost nothing. Another added advantage is that a company does not have to worry about the traffic it can host on its servers. If the demand increases the cloud can accommodate it in no time. Cloud services are running on a pay-per-use model. You pay for only as much as you use. That's almost like the electricity we pay for. That's one reason why experts compare this form of computing to Power Grid supplying electricity and billing for the usage.

Google Apps and Microsoft's Windows Live are popular cloud based services that are providing computing solutions normally found on PCs. The kind of hardware and technology required to drive Cloud Computing into the common man's home is not available as of now. Like every other emerging technology, THE CLOUD will take time to be adopted universally.

Another big step towards popularizing and perhaps the most substantial step forwards is the expected launch of Google's Chrome OS. The OS is going to be solely web based and one of a kind.

Is my data safe in cloud?
That's a question a lot of people are asking and is an extremely crucial one too. More so, when the web is teeming with hackers and privacy issues abound. Another concern is the availability of data in case of a system crash or maybe physical damage to the remote servers that store the data.

Where does India stand?
Accessibility of The Cloud depends largely on the availability of high speed internet connections, especially wireless. India lags behind in terms of broadband penetration compared to China, which has shown rapid growth in its subscriber base. Even the US, doesn't compare in numbers to that of Europe in terms of internet connections. There lies a major roadblock in expanding this technology. The exorbitant data charges in India are proving a deterrent for a lot of people who actually feel the need for an internet connection. Every cloud has a silver lining though; Infosys, the first Indian company on NASDAQ, has adopted the Cloud to leverage its services to a number of its clients. Here lies the catch, when a lot of companies are adopting the cloud as the preferred technology for data handling and many other services, the necessary infrastructure or high speed connections required to keep pace with this technology is lacking in a lot of countries. It's only a matter of time though, the Cloud is going to come knocking at our doors. If you are thinking of buying a high end PC, think again, you might just do as well with a really quick internet connection.

Source of images
www.sizzledcore.com

About the author
Malik Rafi is a third year undergraduate in the Department of Electronics Engineering, ZHCET, Aligarh Muslim University. His research interests include robotics. He can be contacted at malik.muhammad88@gmail.com.

Throwing stones at the foundations

Interview with Dr. Anthony Leggett

He is urging the scientific community to relook into the very foundations of Quantum Mechanics. The following is a review of the public lecture delivered by, and an interview with -Professor Anthony Leggett, the 2003 Nobel Laureate in physics, the man who's teaching us to look at things from a new perspective.

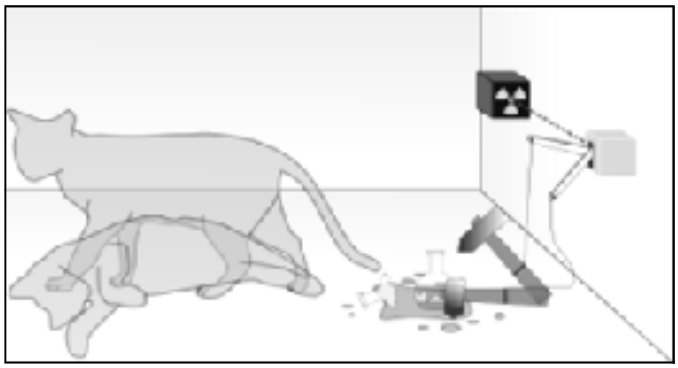

Dr. Anthony Leggett

Dr. Leggett is recognized as a world leader in the theory of low-temperature physics and was awarded the 2003 Nobel Prize in Physics for pioneering contributions to the theory of superconductors and superfluids. He has a significant contribution towards our theoretical understanding of superfluidity.

Now, he is working on, among other topics, the theory of experiments to test whether the formalism of quantum mechanics will continue to describe the physical world as we push it up from the atomic level towards that of everyday life. While at IIT Kanpur, he delivered a lecture titled "Does the everyday world really obey quantum mechanics?" as a joint session for the International Centre for Theoretical Sciences Program on Non-Equilibrium Statistical Physics and the conference on Interaction, Instability, Transport and Kinetics: Glassiness and Jamming (IIT Kanpur: Golden Jubilee). The talk focused at the idea that even after it's numerous triumphs, Quantum Mechanics still cannot explain the macroscopic world completely.

The cat out of the box?

The public lecture started with Professor Leggett pointing towards the 'weird' nature of the Quantum Mechanical description of nature. In quantum mechanics the state of every particle is described by a wavefunction, which is a mathematical representation used to calculate the probability for it to be found in a location or a state of motion. One of the most widely accepted interpretations of Quantum Mechanics is the so called Copenhagen Interpretation which asserts that the act of measurement causes the calculated set of probabilities to "collapse" to the value defined by the measurement. The Schrodinger's cat is a thought experiment that was intended to illustrate the bizarreness of the world of quantum mechanics and the mathematics necessary to describe it. In the words of Schrodinger himself:



"A cat is penned up in a steel chamber, along with the following device: in a Geiger counter, there is a tiny bit of radioactive substance, so small that perhaps in the course of the hour, one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges, and through a relay releases a hammer that shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The psi-function of the entire system would express this by having in it the living and dead cat' mixed or smeared out in equal parts."

An indeterminacy originally restricted to the atomic domain becomes transformed into macroscopic indeterminacy, which can then be resolved by direct observation.

Here, professor Leggett pointed out a very important gap in our understanding of the quantum picture of the universe. We are still not sure how Quantum Mechanics manifests itself on a macroscopic scale. He pointed out that the Cat paradox could be resolved in one of the two ways:

a. Assume that Quantum Mechanics is universal. This can be interpreted as any of the following three:

1. It is because of decoherent quantum interference that, on a macroscopic scale, the effects vanishes; just like the uniform light produced by two light bulbs lighting the room.
2· Many Worlds: The experiment would lead to different outcomes in different worlds. In very simple language, there are a very large number of universes, and everything that could possibly have happened in our past, has occurred in the past of some other universe or universes.
3. Extreme statistical: the logical extension of the Copenhagen interpretation.

b. Assume that quantum mechanics breaks down at a certain point en route from the atom to the cat.
There are different attempts to explain the paradox in this manner, of which the GRWP (Ghirardi, Rimini, Weber, Pearle) theory is the most significant and tries to explain the paradox using the idea of a universal non-Quantum Mechanical noise background.

He further addresses whether we will ever be able to tell if Quantum Mechanics is the whole truth and the answer was clear: "We'll have to find newer systems for the same, the systems where 'decoherence' is not effective." Such systems, he said, are very likely of being found in the domains of Condensed Matter Physics. The Superconducting Quantum Interference Device or SQUID may serve as the ideal system for the same.

There is considerable work that is left to be done in this area which has been considered to be the foundation of most of the work done in the last 70 odd years in physics. Maybe sometimes, it actually is a good idea to throw stones at the foundations.

Write up by Ish Dhand

Source of image:
http://www.babble.com/CS/blogs/strollerderby/archive/2009/04/08/for-the-baby-science-geek-pat-schrodinger-s-kitty.aspx

Here are some excerpts from the interview with Dr. Leggett:

NERD: Sir, please tell us about your work in low temperature physics.
Dr. Leggett: My major interest in low temperature physics has historically been in Helium-3. I was pretty lucky to be around and get some early information when the first experiments came out in 1972 and I started thinking of a theory to interpret what was going on in the experiments and one thing led to another. There was a long period in my work in the 70's and the 80's when I was mostly working on the superfluidity of Helium-3. That leads to a very interesting system because you have cooper pairs formed just as in superconductors but they have internal degrees of freedom. That's one of my interests. I'm also interested in the ultra cold bosons in optical lattices and one of the less popular interests of mine is the low temperature property of glasses and that's not very trivial.

NERD: You have received numerous honours ranging from the 2003 Nobel Prize in Physics, to the Wolf Foundation Prize, the Paul Dirac medal and the Maxwell medal. What do you think is your most fundamental contribution to Physics?
Dr. Leggett: I have been somewhat instrumental in getting to people to look at direction of quantum mechanics in the macroscopic limit.

NERD: How did you choose the problem that you have been working on? It's a broad domain ranging from the work on low temperature physics to the work that you now spoke about?
Dr. Leggett: Well, I think I just tried to spot an area or problem where we tentatively come to an understanding. I don't have much taste in doing calculations, or problem where I can intuitively see roughly what will come out. I find the arrow of time, the behavior of Superfluid Helium-3, and others genuinely puzzling, and therefore like to work on them. These seem to be throwing some big question marks to the scientific talk.

NERD: Many students would be interested to know about the path that you followed for undergraduate education and the kind of passion you had in physics.
Dr. Leggett: Actually I did not have any! I had essentially no interest in physics at high school. My father was a teacher in a school who used to teach physics, mathematics and chemistry. He never pressed me to go into physics. So I was doing my majors in languages and after being trained to Year 3-4 of undergraduate level at Oxford I started seriously contemplating upon my career options, but by a curious route concluded that I might be cut out for a career

in academic physics.

NERD: What's your take on undergraduate Research?
Dr. Leggett: Well, it can be done. I think in some sense, the obstacles to doing it tend to be more administrative than scientific. We certainly try at the university to involve ourselves more in the undergraduate education as much as we can.

NERD: You've spoken extensively about the coupling between the theoretical and experimental aspects of science. With this explosion of Quantum information and allied sciences, does the importance of this coupling change?
Dr. Leggett: I don't think so. I fully believe myself that there is a strong coupling between the two. I consider it my responsibility to find out what my experimental colleagues are doing and not to just go on working in theory.

NERD: There's another dimension growing very rapidly these days - numerical computation. How do you think that it compliments theory and experiment?
Dr. Leggett: It's really neither experiment nor theory. Personally, I think that there is too much computation going on in physics right now. A lot of work is done computationally that can be done analytically because people are too lazy to carry it out.

NERD: What are the other topics that you have been working on in the recent past?
Dr. Leggett: There are topics in traditional condensed matter physics. I think that the basic problem which I am most interested in right now is the question of the arrow of time. It's a non trivial problem in my opinion.

NERD: How sure are we today that Quantum Mechanics is the whole truth of the world?
Dr. Leggett: I would take it fairly large bet that in the year 3000, people are not going to believe that Quantum Mechanics is the whole truth. Don't ask me what's going to replace it because I don't know what it'll be!

NERD: A while back, when the LHC experiments were coming up, there were speculations that as soon as they are clear about all the particles and all the interactions, they would know the physics of everything and very soon we will have a theory of everything. Being a condensed matter physicist, what's your take on that?
Dr. Leggett: Well, the high energy physicists who make these claims should try predicting weather for tomorrow. I hate to admit that the people will find, after having fully understood exactly what the possible elementary particles and their interactions are, we are not able to predict the weather for tomorrow.

NERD: Describe Dr. Anthony Leggett in one line?
Dr. Leggett: Here's a quote of Horace in latin– "Nullius addictus jurare in verba magistri". This basically means that I am not prepared to swear to the words of any master, that basically I don't take the doctrine of anyone on trust, however distinguished they may be, not even Neils Bohr.

NERD: What is your final message to the students?
Dr. Leggett: Try to follow your intellectual curiosity when you do a piece of scientific work, do it as honestly and carefully as possible. Don't worry for some external rewards. They'll come if you do follow your curiosity.

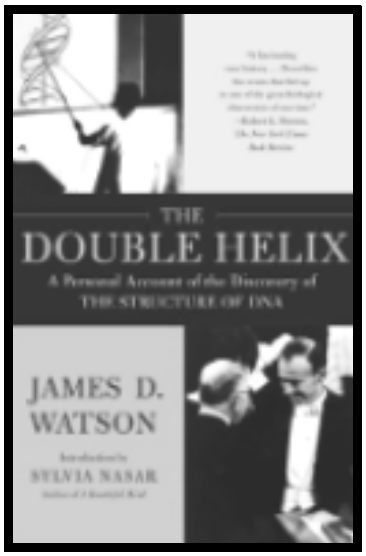
Interview taken by Bhuvnesh Goyal and Ish Dhand

Bhuvnesh Goyal (bhuvnesh@iitk.ac.in) is a second year undergraduate in the Department of Computer Science and Engineering at IIT Kanpur. He is a member of core-coordination committee, NERD and can be reached at bhuvnesh@iitk.ac.in. He loves writing on wildlife and is interested in sociobiology.

Ish Dhand (ishdhand@iitk.ac.in) is a second year undergraduate in the Department of Computer Science and Engineering at IIT Kanpur. He is passionate about physics.

Development of materials for healthcare

One of the most prevalent health problems among humans today are musculoskeletal disorders. In spite of herculean magnitude of this embargo, there is still a lack of bone replacement material that is appropriate for restoring lost structure and function, particularly for load bearing applications. Also, it is being thought that the materials used today (including titanium, CoCrMo, etc) as bone fixation or replacement devices have an overall average implant lifetime of only 10 to 15 years. At the Laboratory for Biomaterials in the department of Materials and Metallurgical Engineering, the focus has been to develop designed materials for orthopedic implants which can restore proper functionality and has longer life. Read the full article by Dr. Bikramjit Basu (Associate Professor and PK Kelkar Research Fellow, Department of Materials and Metallurgical Engineering, IIT Kanpur) on the NERD website: www.iitk.ac.in/nerd (the site will be up shortly)



DOG-EARED

Book review- Double Helix by James D. Watson

Pranjal Nayak

Author: **James D. Watson**
ISBN: 074321630X
ISBN-13: 9780743216302, 978-0743216302
Binding: Paperback
Publishing Date: Jun 2001
Publisher: Touchstone Books
Number of Pages: 256
Language: English
Book Club Availability: 1

Let the readers not be discouraged by the thought of having to study biology again in this book. This book is all about how a scientist recalls the moments of being successful. This book cannot be called an auto -biography because it is not a life story of the scientist. James D. Watson just shares his experience of the years in which he worked with Francis Crick and others to discover the double-helical structure of DNA. In a beautiful story-telling way the author discusses what he felt about the different people that he met in these years and how they all affected his work, scientifically or socially. He talks about the problems the two collaborators had to face in convincing the people they worked for that their research is worth the time, effort and money. It also mentions how the Cambridge-Oxford rivalry made life more difficult for them. The pressure that Watson had to face in convincing his scholarship providers. And yet it is not all about the struggle but the fun that lies behind doing something that you really like.

One thing that impressed me in the book was the way the first half has been written. Watson keeps talking about everyone but him, the important work they did and how very more intelligent they were in comparison to him so that at one point one may even forget that he was the one to have done the great job. It's not that he did it out of courtesy but the fact being that at the time which the first part describes probably he hadn't truly done that much work. You know it because later he duly takes credit for all the work that he had actually done, especially when he gets the final idea. And yes, although I don't want it to be a spoiler, but the end comes so easily that for once you might doubt the solution to be that easy. And that is one beautiful thing in the book that you can't ignore- its easy going description of things!

And to wind it up, the book is good to know what a discoverer thinks of his achievements, looking back at all the events that took place, and recalling how he felt. By no means does this book give an impartial or only-slightly- biased version of the history, but history from the eyes of someone involved and his views about the things that happened and people involved. So as is obvious, this has been a controversial book, especially in description on Rosalind Franklin, a lady researcher at King's College London, who has been portrayed as a tough and testing woman to work with. Nevertheless the book is fun to read.

About the Author

Pranjal Nayak (pran@iitk.ac.in) is a second year undergraduate student in the Department of Mechanical Engineering at IIT Kanpur. He is the member of Core-coordination committee, NERD.

Addendum/ Errata

(for NERD Vol. 2 No. 2) Abhyast: Boeing- IIT Kanpur - Autonomous Vehicle Project *(Page 14):* We missed out the name of Palash Soni (palash@iitk.ac.in) as one of the authors. Palash Soni is a 3rd year undergraduate in the Department of Electrical Engineering at IIT Kanpur. His research interests include biomedical signal processing and statistics. Apart from these, he is also interested in social entrepreneurship. Our apologies!

Purifying The Purifiers

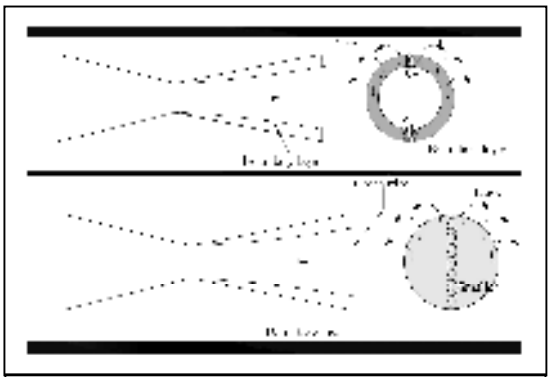
Otana Jakpor

Even though air purifiers are marketed to asthmatics and others to improve breathing, some air purifiers emit harmful ozone—a key component of smog. This study examines the hypothesis that ozone-generating air purifiers and other household devices that generate ozone may have a negative effect on pulmonary function. According to a recent study by the California Air Resources Board, ten per cent of California households own an air purifier that may produce ozoneNo published studies on the direct pulmonary effects of these air purifiers have been found on Medline. Read the full original medical research and public policy advocacy on the pulmonary effects of ozone-generating air purifiers by fifteen-year-old Otana Jakpor on the NERD website: www.iitk.ac.in/nerd (the site will be up shortly). She is the recipient of President's Environmental Youth Award, 2008. It was due to her efforts that California became the first state in the United States to limit ozone emissions from air purifiers.

The article was originally published in Young Scientists Journal issue7, Jan-Feb 2009, page 2, with permission.

Rathakrishnan Limit

Ethirajan Rathakrishnan is Professor of Aerospace Engineering at Indian Institute of Technology Kanpur. He is well known internationally for his research in the area of high-speed jets. The limit for the passive control of jets called "Rathakrishnan Limit" is his contribution to field of jet research and the concept of breathing blunt nose (BBN), which reduces the positive pressure at the nose and increases the low-pressure at the base simultaneously, is contribution to drag reduction at hypersonic speeds.



The tabs (upper) and cross-wire running across

The tabs running across a diameter were used as a passive control to enhance the jet mixing and attenuate jet noise. The streamwise vortices introduced by the limiting tab leads to a more rapid decay of the centerline pitot pressure. Also, the tab weakens the shocks in the jet core significantly. The author had authentically proved that the limit for tab length is the nozzle exit radius and not the boundary layer thickness. This limit of tab length is popularly known as Rathakrishnan limit in the technological world. He has published many research articles in many reputed international journals. He is Fellow of many professional societies, including Royal Aeronautical Society. Professor Rathakrishnan serves as the Editor-In-Chief of International Review of Aerospace Engineering (IREASE) Journal.

He has authored eight book: Gas Dynamics, 3rd ed. (PHI Learning, New Delhi, 2010), Fundamentals of Engineering Thermodynamics, 2nd ed. (PHI Learning, New Delhi, 2005), Fluid Mechanics: An Introduction, 2nd ed. (PHI Learning, New Delhi, 2007), Gas Tables, 2nd ed. (Universities Press, India, 2004), Instrumentation, Measurements, and Experiments in Fluids (CRC Press, Taylor & Francis Group, Boca Raton, USA, 2007), Theory of Compressible Flows (Maruzen Co., Ltd. Tokyo, Japan, 2008), Applied Gas Dynamics (John Wiley, 2010) and Work Book on Gas Dynamics (Praise Worthy Price, 2010).

Dignitaries in ICARUS 2010

Dr. K. L. Chopra
President, Society for Scientific Values
Ex- Director, IIT Kharagpur

Dr. Roddam Narasimha
Ex- Director, National Aeronautical Laboratory

Dr. R. Chidambaram
Principal Scientific Advisor, Government of India

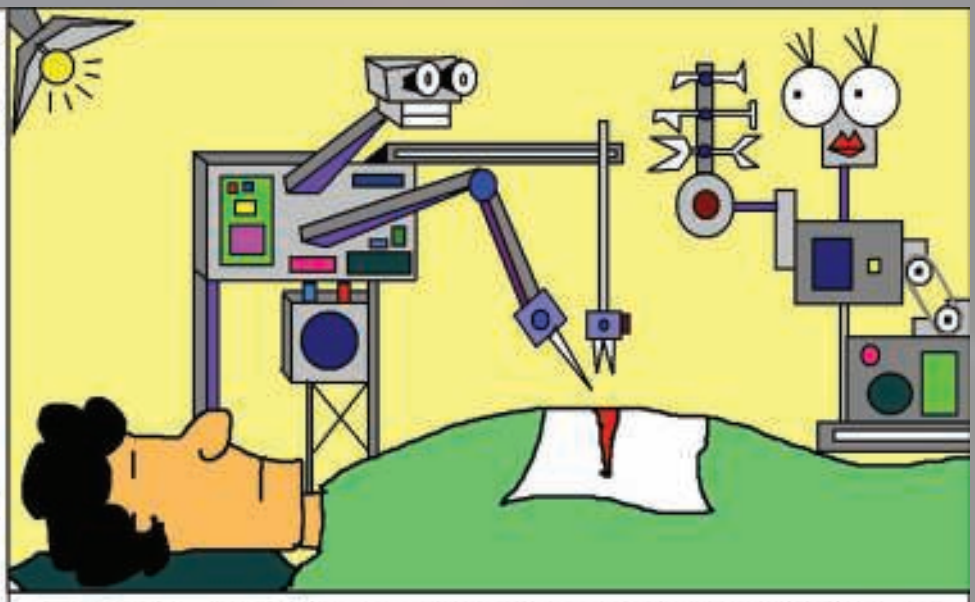
Dr. Vijay Singh
National Coordinator, NIUS
National Coordinator, Science Olympiads,
Homi Bhabha Center for Science Education, Mumbai

CALL FOR ARTICLES

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

SCIENTOON-by Puneet Singh

Most surgeries require nearly a dozen people in the room. As with all automation, surgical robots will eventually eliminate the need for some personnel. In this nearly empty operating room, the doctor sits at a computer console, either in or outside the operating room, using the surgical robot to accomplish what it once took a crowd of people to perform.



"Nurse, hand me another pair of scissors. I think I dropped the one you gave me earlier. Your pretty LEDs are distracting me today"

NERD Magazine, SAC 210, IIT Kanpur, Kanpur 208016, U.P., India
or
mail us at nerd@iitk.ac.in

Also, if you find any kind of plagiarism in any article, mail us at nerd@iitk.ac.in as soon as possible.