Illustration by Roma Singh, IDC

Illustration by Guru Charan Murmu, IDC

Haldu

There are two trees amidst us that go under the name 'kadam'; the one being featured in this issue will here be called the 'true' kadam. Also known as the haldu, this fine tree (*Adina cordifolia*) can grow to an imposing height – up to 30 metres, or high as an 8-storey building – though its lateral spread isn't as luxuriant. While its leaves, somewhat heart-shaped, signify its specific name, they are not clinchingly diagnostic (as several of our trees sport roughly heart-shaped leaves), but its abundant blossoms are. They are small, even inconspicuous (just some 3-4 cm across, like large playing marbles), but on close inspection are quite striking. Each is a perfectly spherical inflorescence, tinged yellow, with its flowers putting out straight delicate styles that form a saintly halo around the cluster. The flowers give way to dark round fruits, and this being the second half of its flowering season, the tree these days bears a mix of the small yellow and brown globes. The best place to spot the haldu is near the hospital, where a couple stand tall, one by the lane that runs parallel to the main avenue, another just to the right of the entrance to the wards. And a loner stands sentinel at a spot rarely visited: the rear of the IDC compound.

PERSPECTIVE

The Structure of Engineering R&D at IIT Bombay

■ **PROF. MILIND SOHONI** Computer Science & Engineering Department

Raintree *on this particular issue focuses on Research and Development at IIT Bombay. While we do periodically read or hear about unique and interesting R&D projects from IITB, in this particular issue, we wished to use the platform of the magazine to focus on more foundational issues. For instance, what does 'research' mean to different people at IITB? The centre piece is a brilliant, thought-provoking article by Milind Sohoni, a professor in the Department of Computer Science and current HoD, CTARA. His article, 'The Structure of Engineering R&D at IIT Bombay' makes some pointed observations on relevance, the connection between research and*

development in the Indian context and the role that IITs should play in this public space. It sparked off a spirited philosophical response from number of others – Prof. Urijit Yajnik, Prof. Srinivas Aluru and Krishna Ramkumar, an erstwhile student and recent alumnus who has made an interesting career choice. Their responses don't just make for interesting reading, but also raise some fundamental concerns within the IITs today. So without further ado or too many details, here are the articles. We hope it stimulates, provokes and inspires all of you to action.

Introduction by **DAMAYANTI BHATTACHARYA**

This note is an informal analysis of the structure and nature of R&D in IIT Bombay. Though I have presented much of the material before (in faculty meetings, students conclaves and so on), it is only here that I have had the space to make a detailed case. I must add that IITB is almost like family for me, and that I believe that its best years are still to come.

I speak here in connection with our R&D in engineering, as opposed to 'pure' or 'blue-sky' research. In what follows, I argue for three basic contentions: (i) our curriculum is too abstract to motivate a suitable and

Inside

The Structure of Engineering R&D at IIT Bombay

broad-based R&D ethos, (ii) our pursuit of international research is misplaced, and finally, (iii) the JEE and GATE adversely impact our R&D efforts. At the end, I suggest a possible change of course, based on notions of engagement, delivery and accountability in engineering.

1. Nature of R&D

While talking about R&D in IIT, I will develop it along two lines, viz., (i) the subject matter and motivation for R&D, which will occupy much of this note, and (ii) the methodology of R&D, which I will outline towards the end. Another observation: for a good education or research institute, one cannot really separate R&D and its practice from curricular teaching. This is because good R&D practice will demand domain skills which motivate curricular training, and curricula define the first perspective by which students will approach new problems. In this sense, the development of curricular material should go hand-in-hand with the agenda for research.

One piece of notation: there are two types of outcomes of a good education, viz., 'conveyance', which enables one to migrate from one society to a better or more attractive one, and 'elevation', which leads to a betterment in-situ. We may extend this to educational institutes, and call them as 'conveyor belts' (e.g., coaching classes, English speaking lessons) or 'elevators' (e.g., electricians' courses, engineering at MIT). It is clear that 'conveyor belt' education will be more about the target society, while 'elevator' education, more about the current one.

Good engineering is about societal problem-solving and is best taught as a partnership between an ambient society and the budding engineer.

My next observation is that the engineering profession is actually fairly social. It began, as with potters or carpenters, by interpreting societal needs in the application domain and its translation into the solution domain. For engineers, the solution domain is the applied physical sciences, i.e., the world of gadgets, computer programmes, pipelines, reactors and such. Of course, there are many other such social professions, e.g., the doctor, the architect, and so on, while many are much less so, e.g., the astronomer, the mathematician and the botanist. Clearly, if you were an engineer, your research would be more solution-driven, while if you were an astronomer, you would enjoy more 'blue-sky' research. Good engineering is about societal problem-solving and is best taught in the elevator mode, as a partnership between an ambient society and the budding engineer. The bottom-line of good engineering is the solution of the problem posed by the end-user in society.

Coming back, important components in the practice of good engineering are (i) good modelling skills (that of observing societal problems and their translation to solution domain) and (ii) good domain skills (from where solutions will arise).

However, if we look at our engineering curriculum, we will see a great deficit in courses on societal modelling, and a great surfeit in the technical and scientific domain. Of course, there are some avenues for 'design', such as the B.Tech or M. Tech project, but here too, largely, the problems are from within the discipline itself, as opposed to from society.

There is one good reason for such a one-sided training and several bad ones. The good reason is that in a developed society, there is an important third player besides the society and the institute, and that is the company. A developed society has complicated needs, such as national defence or multi-continental cuisine, and it is the job of the company to interpret societal needs and devise solutions. These solutions are also complicated and require many disciplinary professionals to work

Illustration by Roma Singh, IDC

together. Moreover, the disciplinary skills required may also be very complicated, needing many years of training in one single aspect of one particular phenomenon, e.g., microwaves, or turbulence. This complicated training must then be imparted by the institute. Thus, the developed society cycle separates the process of engineering: (i) problem modelling, specification and delivery which is done by the company, and (ii) solution, which is devised by the employee engineer. The institute's role is to train the employee engineer.

2. The Abstract-scientific Paradigm

In 1958, when IITB started, its curriculum was influenced by MIT and other elite universities of the west. The west consisted, of course, of developed societies which were (and are) deeply multi-party, i.e., society-institute-company. In fact, these societies have an additional important and big player called the government. The government formulates laws, enables and enforces contracts, regulates companies, invests in institutions and so on. Further, these societies were (and are) generally well-served by their companies and

The agenda and methodology of 'world-class research' was achieved by defining it to be measured by 'papers in international journals'.

their governments, while we were (and are) not. It is instructive that around the 1950s, MIT itself was migrating in its paradigm for doing engineering. Its earlier model relied heavily on neighbourhood industries such as Westinghouse, to decide curricula and to absorb its output. In fact, in 1925, the Electrical Engineering faculty had just one PhD and was dominated by a practitioner faculty with a bachelor in engineering with lots of industrial experience. However, during the World War II and post-Sputnik, newer companies came to dominate the scene, and these companies relied heavily on core scientific research. This was the era of transistors, aviation, nuclear energy, mass telephony, new materials. Thus, science came into the engineering curriculum in a big way. For a historical perspective, see Prof. Terman's article on the electrical engineering education at MIT.[1] Also see, Prof. Ross Bassetts' article[2] on a strategic analysis of the interaction of IITs, specially IIT Kanpur with MIT and other American universities.

This new highly scientific/analytical model presupposed doubly-well-developedness, i.e., there are (i)

basic companies which interpret societal needs and service them, and (ii) high-tech companies which are innovating for future societal needs and which invest in long-term, basic R&D. It is this somewhat abstract-scientific model of engineering education that we adopted and installed into our IITs.

Ironically enough, the only part in which there could have been some society-specific inputs was in the Humanities and Social Sciences department. They were there in the MIT curriculum as a part of the classics tradition of all western elite education. We made these into abstract courses with foreign textbooks and little or no live societal content.

At that time, in the US, there were several engineering education or research models, e.g., the industrial model of Michigan or Delaware, the state development model of Minnesota, and so on. But we chose to copy the 'best'.

Note that there were, at that time, quite a few engineering colleges in India, some of which were following the older MIT company/sector model of close interaction with specific industries, e.g., UDCT (now UICT, Mumbai) of Bombay, with the Chemical Engineering industry, or older still, Rourkee (now IIT Rourkee) with the irrigation sector. Others catered to the local general society and its engineering companies, such as the College of Engineering, Pune. These colleges had a simple contract with the society or industry (i.e., the supply of suitably trained engineers for socially and economically important companies and sectors).

Certainly, the doubly-well-developedness assumption, central to the abstract-scientific MIT model does not hold here in India. So, it is essential that we examine the suitability of this paradigm for ourselves.

The obvious question was: who would find this new paradigm useful and how would the IITs be sustainable at all? From the government's side, this was ensured by several provisions. First, there was substantial budgetary support and autonomy, much above the norm for other existing engineering colleges. Secondly, there were few teachers who had exposure to the west, and the number of IITs was just enough to match this small supply of teachers of abstraction. Finally, the curriculum was taught well, specially at the undergraduate level.

The abstraction was indeed a new ingredient in the Indian engineering education system and was well appreciated by the industry and complemented with

their domain-specific skill-set. They looked forward to students' entry and participation into the Indian industry.

For students, the pearly gates into the IITs were guarded by the wizard of JEE which was an exam of simply stated questions with intricate solutions of intriguing symmetry. The curriculum extended this journey, though after a while, it got tiresome for many. Theoretical insights raced ahead of the laboratory instruments and were constrained only by one's imagination. The abstract world of charged spheres in infinite 3-dimensional space, quantum oscillators, or Bessel's equations, was just the right distance from a grubby, poor and clasping society.

The urban upper class and the upper castes just loved the IITs for its access to the west, and for its monastic setting. The JEE was a hit and the brand-name IIT was born. Almost from the first batch itself, going to the US was the norm for the upper half of the class. This was but a natural extension of the education that they had received. The industry got a few employees, but the dominant paradigm was to go to the US. Thus, right at the beginning, what was the 'elevator' at MIT became a 'conveyor belt' here – of escape to a richer society.

The conveyor belt was later modified. By the 1980s, the US had had enough of engineers, and the socioeconomic profile of our students had also changed. The 'higher education' route fell out of favour. Of course, the top guys kept going to the top universities, but there were easier options available for those lower down. The IT boom was just starting, which eventually created the body-shop and other commoditised engineering services job, and their upscale cousins (the consultancy/banking jobs). These jobs were a reasonable compromise (they were half-way between the first world and the third, they had excellent perks, they were abstract enough to be reasonably exclusive, and mainly, they were simple enough to get for the average IITian). It is this warm-body job which continues to be the lure for the IIT aspirant.

In the past few years, two types of jobs seem to have gained primacy as jobs for engineers: (i) the brand-name networked jobs (e.g., management track in MNCs in India, foreign banks, consultancies), and (ii) the IT and commoditised engineering services jobs (Infosys, foreign banks, IT, GM, Intel-India, and so on). Many supposedly core-sector jobs (such as Fluent, Motorola, etc.) are also fairly commoditised back-end jobs, far far away from the market place and society. Both jobs need very little of the abstract-scientific training that we purport to give. What they really need are (i) foremost, an ability to do easy things fast (ii) some project management and documentation experience, and (iii) a brand-name college and its network support.

The extreme odds cause JEE and GATE to be highly coached, thus distorting what the exam actually measures.

These warm-body jobs are numerous, especially in multinationals. They also pay well and have many perks, such as international travel, and don't need too much hard-thinking. These jobs are, of course, a far cry from actual, developed-world engineering design jobs such as designing the Airbus undercarriage (in Osaka), or dentists' chairs (in Canada), or say toothbrush-making machines (in Italy). Unfortunately, these warm-body commoditised jobs seem to be at the apex of our engineering job market.

3. The Research Agenda

There was not much research visible in the early years. If any, most of it was done quietly by the M.Techs, who were admitted by individual departments in an exam-cum-interview procedure with little fanfare. These unsung heroes went back into the woodworks of the Indian industry, largely forgotten and eclipsed by their prodigal cousins, the undergraduates (UGs). The UGs did B.Tech projects, which were typically on topics which were the rage internationally, and which would help their application to foreign universities.

That didn't really count as research, for there was nothing to deliver and nobody to receive it. However with time, the faculty and officers of IIT wanted an elevation from a teaching institute to a research institute, much like the US universities. It was then that we first heard calls for IIT to be a 'world class university' doing 'world-class' research. But what is to be this world-class research, who is to fund it and who is to do it?

The agenda and methodology of 'world-class research' was achieved by defining it to be measured by 'papers in international journals'. This was done officially, via faculty selection and promotion guidelines, funding for travel and so on. Of course, 'international journals' meant those from the developed world.

Also obviously, the agenda and methodology of 'international journals', would be 'international', i.e.,problems of relevance to the state, society and company of the developed world.

However, for an Indian student or teacher, company or implementation agency, these journals are expensive, inaccessible and largely irrelevant. It is a deep sociological (and 'international') research problem as to why we should have decided on this particular yardstick for measuring our research.

Perhaps it was simply because it is easy to implement and is conveyor-friendly. Or maybe there is some question about whether a problem such as the 'drinking water problem' is really a research agenda at all, and not an outcome of the endemic corruption of our common people. Or that 'drinking water' is indeed a technical problem, but it is for other Indian institutes to address. Quite possibly, working on a 'drinking water' problem is really an emotional or spiritual pursuit, best left outside an abstract-scientific institute. There is also the 'enlightened' viewpoint that we all, the west and the east, have a common destiny (and a common excellence), and that eventually, the trickle-down tide will raise all boats. This is not borne out by the data: the disparity is increasing, and most visions of this common destiny (such as a car for every household) are unsustainable.

Style versus Sincerity

■ JAYA JOSHI

In case you have not noticed, my edits, over a period of time have become confessional. Mildly, but still. And this issue of *Raintree* being the second anniversary issue, I'll share a big one. For most of my professional and personal life I have strictly followed one of Oscar Wilde's most important advises to the youth. He says: In all unimportant matters, style not sincerity is the essential. In all important matters, style not sincerity is the essential. How successful have I been? We'll see.

I, who cannot recall anything without error, still vividly remember the 45-odd minute long interview for this job. I didn't realise how and when, somewhere during those involved discussions and dialogues my approach towards this job changed from being amused to being provoked. And I think even before the offer was made to me, I had in my mind already accorded a serious role to this position. One of the things that I had earnestly promised my interviewing panel, (Profs. Khakhar, Krithi and Misra will vouch for it, as they were a part of it) was to create the right buzz and noise, nationally and internationally around the high quality research work happening at IIT Bombay. To position IIT Bombay as a leading institute that is constantly engaged in doing socially relevant R&D work. I got here with my regular plans in my folder and a fervent desire like a teenager for the first time in a long time for doing PR. It felt like I was floating in a sea of opportunities and getting a chance to do some good honest work like never before. It was all there already. All I had to do was bring it out for everyone to see. Pretty basic, I said. You can tell it was an emotional time.

My first year was the most entertaining, as the contrast from my previous life to this one was quite stark. From being surrounded by bosses and clients who would meet daily, keenly follow the efficacy of PR plans and never be satisfied with any amounts of visibility, I was now surrounded by fiercely shy and reticent celestial beings in the form of professors (most of them doing excellent work) who wanted to stay away from any kind of publicity. I had never met this breed before. It was refreshing and very enjoyable. I was so much more determined to do something for this shy, modest and deserving community and institution. My emotional side was still raw and tender, you can easily guess.

The plan was simple or so I thought. Write two or three R&D stories a month and get them placed in the national and regional media. Do it on a consistent basis so that the international journals (not research journals please, just good old newspapers and magazines) start noticing and picking them up too. It's been over three years and I'm still working on the creating those buzzes and noises. In all honesty, as far PR for R&D goes, I wonder if we are being heard at all. Why is it taking so long? I don't have the answer yet. Not a complete one. But I'm looking and I'm hopeful that I'm not too far.

This issue of *Raintree* is themed around the topic of Research and Development at IIT Bombay and presents some scintillating conversations, perspectives, opinions, points and counter-points and a few R&D projects too. They are thought-provoking, asking some tough questions and even offering solutions. Putting this issue together was like experiencing a range of emotions I didn't know existed in me. It has everything – from the most serious, serious articles to the most seriously humourous articles. The humour section, this time has been led by our esteemed panel of alumni including Hemendra Godbole, Bakul Desai and Dhaval Dalal. Be warned – it's rib-tickling and not for the faint-hearted.

This issue, once again brings back some beautiful and inspired illustrations. A lot of work went in to creating these art pieces by Roma, Ankita, Regan, Narendra, Gurucharan, Jaya, Mugdha, Utkarsh and Akvil. I hope you will notice and enjoy.

And before I close, I'll go back to my original question. Is it important to be earnest, and should you choose it over style? You will let me know. Right? ■

Letters to the Editor
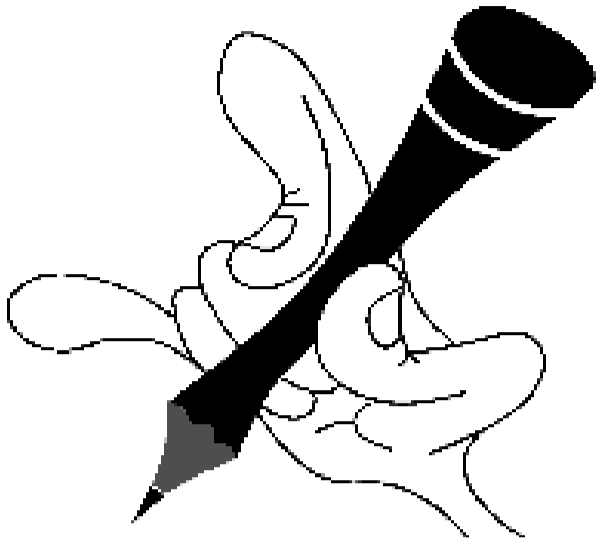
I just went through your interview on Raintree which appeared in the Personality section of the previous issue today. It felt great going through it. All the incidents you mentioned about in the interview are indeed insightful. The article sure has so many things to take back and implement in life.

I would just like to share this small incident regarding ethics just a few days back. Me and a friend of mine were on a railway station at 6 am in the morning. He did not buy a ticket because he was sure there wouldn't be a TC at such an odd time and asked me to do the same. It was then that I remembered your lines in class that "You should not buy a ticket due to the fear of a TC catching you ticketless; but you should buy it because you are legally required to buy a ticket while travelling on a train." And with that thought, I bought the ticket. Incidentally we encountered a TC on the station just a few minutes later, my friend had to shell out money and all I did was thank you in my mind for those precious words you had shared with us.

Thanks once again for all the knowledge you have given to me, both the technical CS 101 knowledge and also the very important lessons in ethics. I am indeed indebted to you for all that. I feel really proud and lucky to have been one of your students.

Thank You for everything you have given me once again.
Ketav Mehta, CS 101 Batch in 2009 Autumn Semester

Congratulations on being conferred with the prestigious awards. I have really enjoyed recent issues for their varied coverage and excellent content. Wish you all the very best in future.
Anand Khusre

Three cheers for the creative and out-of-the-beaten-track spirit, and hope it continues this way.
Ravi Banavar

Congratulations !!
Winning against 497 contenders, with the lowest budget – in both categories is HUGE!
Hemendra Godbole

My compliments on the most recent issue of Rain Tree. Very solid content and well produced as well. Please convey my compliments to the entire team.
Devang Khakhar

Congratulations to the "Raintree Team". I think your selection of the theme for this issue is very relevant.
Hari Pandalai

I am so so happy for you and your team.

IITs, whatever they are known for, is because for a lot of us it's really been a labor of love.

Keep at it...lots of people even at IIT Kanpur, enjoy

reading Raintree...and have often asked me when the next issue is coming.
S. K. Gupta

Congratulations! This is excellent news and a great achievement in a crowded space and with scarce resources.
Suresh Shenoy

Congratulations on winning these two popular ICE awards. I am sure you will continue this good work and bring more laurels to the Institute.
Krishna V. K. Rao

I like reading Raintree over a period of a few days and will certainly love to have a print copy and I would not mind paying the cost.
Dipak Sheth

It is indeed a great piece of news for the institute and rightly put as a labour of love! All the best with many more interesting editions and more of such accolades.
Chitra Chandrashekhar

Congratulations to the Raintree team for receiving awards from ICE. These honors are well deserved. I read internal communications of many corporations and universities and Raintree does stand out as an exemplary magazine. I enjoy reading every issue. It communicates and connects. We wish you and the Raintree team greater successes.
Pradeep Anand

I notice many new features in the Raintree publication and I read them with much interest. I am an octogenarian and would prefer to have the printed publication so that I can read the same leisurely.
Thanking you.
A. K. De

The Structure of Engineering R&D at IIT Bombay *(contd. from page 3)*

Anyway, our current research agenda includes subjects such as Proteomics, Spintronics, Nanoelectronics and so on. It is unclear how these technologies will be delivered to the Indian society in any way, directly or under-the-hood. What is also unclear is how we will achieve excellence in Proteomics, a tool motivated by problems of a different society, of which we and our students have very little first-hand experience. In my opinion, as far as IITs matter to the common people of this country, this ducking on the definition of the research agenda remains a serious weakness.

4. The Admission Process

Another big influence on our R&D is our admission process, viz., the JEE and GATE (which started around 1984). The JEE is, of course, a big disaster in the education sector in India. At an acceptance rate of 1-in-60, it is more competitive than Cornell Engineering (1-in-2), Illinois (1-in-3), Michigan (1-in-4), and Harvard (1-in-13). Compared to the IITs, all these colleges have much better and widely experienced faculty, provide much better and well-rounded education and are perhaps cheaper (if you factor in coaching class fees).

These reasonable acceptance ratios for US universities actually come from a broad-basing and inclusivity of education, its objectives and its delivery. This fact seems to be lost on us. In fact, the need for exceptional 'merit' to be taught a skill as simple as engineeringis a hallmark of the elitism present in our society. Another hallmark is that UNDP predicts that we will be the last society in the world (behind e.g., Burundi, Rwanda, Papua-New Guinea, the Sahel) to get rid of poverty and starvation.

The JEE is propagated by:
i. IITs defining what an engineering education means. For example, IIT says that Fluid Mechanics II is a core subject in Civil Engineering, and is liable to be tested in GATE. This is oblivious to the fact much

Illustration by Roma Singh, IDC

water in India is carried on the heads of little girls, and not through pipes where turbulence (taught in detail in Fluid Mechanics II) is a problem.
ii. MHRD, DST and AICTE, which acquiesce to this definition and subsidise (through huge budgetary allocations and 'research grants') the IITs to such an extent, that other engineering colleges cannot afford to run any race or define an alternate engineering paradigm. Besides, there are too few good teachers of abstract engineering to copy the IITs.
iii. A troupe of consolidated brand-name companies (Morgan Stanley, Proctor-Gamble) or high-tech globalised, commoditised engineering companies (Infosys, Intel, GM) rather than core engineering companies for a developing nation. Their requirement for branded warm-bodies matches exactly with what the IITs supply.

This last point actually causes much damage: it creates a student body which has put in a lot of effort to get in, and

sees very little additional utility in studying any further. In fact, 'rational' students spend more time in managing various programmes, building contacts and networking.

Thus, the JEE contributes to the primacy of a single viewpoint on engineering education, specially one with very few teachers able to teach it, and a pecking order in jobs in which the true engineering jobs are much lower down.

Besides this, the extreme odds cause JEE and GATE to be highly coached, thus distorting what the exam actually measures. In fact, the JEE promotes a paradoxical situation where engaging in amateur engineering (say, building a theodolite) actually reduces the chances of passing JEE because of the 'wasted time' in doing so. Further, the sheer number of applicants makes it impossible for IITs to do anything but have an objective-type test with a numeric cut-off. This is a serious lacuna, especially for postgraduate (PGs) admissions, where a more careful multi-criteria process is required.

5. A Review

Let me come back to our stated metric of 'international research' and see how we are doing. In my opinion – badly. Our UG students never bought the international agenda. The easy warm-body job is the primary reason why our current student joins IIT. As regards PGs, s/he too is increasingly similarly disposed.

Large-scale student disinterest in academics and their preoccupation with placements, IIMs, IAS, etc. is well documented. That leaves only the PhDs. For all our efforts, the good PhD student is still elusive. At first sight, there seem to be few successful research areas, such as Microelectronics, but they usually have a multinational job dangling at the end, i.e., employers such as Intel, Motorola who have set up cost-reduction centres in India for the commoditised research professionals that they need. None of these companies have ever designed a chip or system for deeper Indian markets.

Large private company participation in our research has still not materialised. Our institute budget for this year has a ₹180 crore sponsored research component which roughly matches what we get from MHRD. However, most (more than 85%) of this funding comes from government agencies such as DST, DBT, where there is no real notion of delivery. Sponsorships from the industry have been stagnant.

Consultancy money is more difficult to interpret and its benefits to IIT are not easy to assess. In any case, most of it is routine with expected outcomes. There is not a single big achievement to talk of, either in blue-sky research or in applied or mission-oriented work.

The publication count picture is also not very impressive. What's more, the university in the west seems to have moved away from mere publications (see for example, the faculty home-pages of Stanford, Civil & Environmental Engineering,[4] and the diversity of output of individual faculty members). The university in the west is now grappling with new problems of energy security, climate change and resource use. This has created a new clutch of companies and consortiums seeking a new contract with (their view of) a globalised society. Thus, students from western universities are studying inter-disciplinary with a new fervour and travelling to India, the Far-East, and into Africa, interacting with society, delivering solutions, offering discourse and influencing governments. So don't be surprised if the Government of Madhya Pradesh calls the University of Pennsylvania for advice on water-quality testing and storage, or if the Mumbai Municipal Corporation consults the London School of Economics on a new property tax regime. Thus, just when we thought we would catch up with the publication counts, the western university has moved the goal-posts.

It may be of interest here that IITB played an important role in starting the IT and commoditised engineering services boom. Through the World Bank funded IMPACT project of 1989, we developed curricula for other engineering colleges in IT/CS/EE and spent considerable time and effort in teaching the teachers. A copy of the World Bank Post-Project report of 1997 will confirm this.[5] To my knowledge, up until recently, this is perhaps the only instance when IITB actually interacted with other engineering colleges in such a systematic way. Unfortunately, the subject matter was IT, Computer Science and Electrical Engineering, and not Civil or Mechanical engineering, and the output of these colleges were to serve in the 'international' market, and not in our own society. Even as late as in 2008, more than 98% of Infosys's revenue came from abroad. And guess what – IBM was the largest IT service provider to India[3]. In fact, the IT boom actually diverted a huge amount of engineering talent away from core engineering and into international service. This caused the costs of international IT to come down, but also raised the costs of a domestic civil engineer, something we could ill afford.

The effect of such poor and lop-sided engineering practice in the public space has had very bad consequences, especially for our infrastructure. Ironically, a new World Bank report now laments this and recommends more civil engineering courses.[6]

Many jobs in the public sector lie vacant, simply because the available talent for the given wages cannot generate the required value. Local bridges are not built while malls flourish, water quality is awful but colour TVs abound, resources are increasingly scarce and local, electric motors lie unrepaired and hand-pumps broken. Of course, theodolites remain expensive. This break-down of public systems is decreasing the equal access to opportunity and increasing iniquity, which are not healthy signs. If we look at the Human Development Indices, our many poor showings for India are actually engineering failures.

6. What Next?

So where do we go from here? In my opinion, we must go back to the basic role of the social engineer who interprets societal needs and provides solutions, i.e., the 'elevator' model. After all, the final test of good engineering in a society is to see that societal problems are solved – if not by the state or the company, then by the individuals and the institutes.

Let us understand how such a change can be brought about. One may argue that much is beyond IIT's control, such as the warm-body conveyor belts out-paying core engineering, but much more of it actually isn't. IITs can and should influence most factors, specially in the long run. In any case, it will be a long process and one has to be patient. I propose three possible actions, at different levels of our societal hierarchy. All need substantial buy-in from our faculty and students.

> ## Develop programmes that engage and get 'embedded' into governance, e.g., through internships with district collectors, specific consultancy programmes aimed at taluka and district bodies, and so on.

1. Work in the public domain.
Design and implement small and big projects in the public domain. There are many examples of this – a piped water-supply scheme, re-design of public transport system, an energy audit for small towns. Concentrate on field-work and delivery through an engagement with local agencies. These will bring in a confidence in the faculty and students and set up a context for the next task – designing new courses. Who knows, we may also win back the interest of our students in what we do.

The projects could create inter-disciplinary teams across various departments, including, most importantly, the Humanities and Social Sciences. These projects will create a name for IITs as regional knowledge generators and solution providers. These will also serve as illustrative case studies and vehicles of R&D which will inform various implementation agencies.

2. Broaden the engineering academia.
Engage in a dialogue and discussion with all engineering colleges and bring an agreement on a curriculum which is broad, inclusive, and participative and is implementable throughout the country. Develop course material and protocols for developing material for local needs. Develop projects which are executable at different colleges and develop a common platform for discussing action-research. Form a team of resource persons for every course, composed of experts and practitioners. Aim for a hundred good colleges and a thousand good teachers per course. Use question-wise GATE scores to measure areas of strength and weakness. By broad-basing, work towards getting the eventual acceptance ratios for IITs to about 1-in-7.

This may throw up many new and exciting courses such as 'Measuring and Metering' or 'Design of Piped Water Supply' or 'Introduction to Rural Infrastructure and Governance'. Welcome such courses as the definition of engineering for a developing country. Eventually, the banyan tree of 'excellent' research (sophisticated instruments, computer modelling, cutting-edge technologies, etc.) will grow on this fertile soil of a broad-based, practise-driven engineering education.

Develop within the academia, (i) mechanisms for primary work and engagement, and (ii) metrics to measure and reward innovation, creativity and research in this new engineering.

3. Develop a discourse.
Evolve an institutional space for such engineering within the Indian polity and governance structure. This will mean many things, like having a discourse of accountability and rationality in engineering at large, and a facilitation and movement of R&D from agencies such as DST to those closer to delivery, such as Railways and Irrigation, municipal councils and gram panchayats. Engage with implementation agencies and ministries to create room for entrepreneurs and innovators. Develop programmes that engage and get 'embedded' into governance, e.g., through internships with district collectors, specific consultancy programmes aimed at taluka and district bodies, and so on. Work to create an open and independent discourse of engineering and an independent socio-political entity called the university.

7. Engineering as Development

Actually, all three recommendations rely on the leadership position of IIT: this cannot be done by anyone else. The recommendations are not really as radical as they sound. Many faculty members do pursue similar goals, albeit as individuals. Institutional room for some of these changes is there in the Nayudamma Committee Report of 1986, commissioned by the 'visitor' to review the IITs. [7]

It recommended that attention be paid to extension activities, arguing that extension (i) is essential for our country, (ii) is different from 'international' research, and (iii) could be pedagogically exciting and throw up important research problems.

An example of such excellence in relevance is the line-up of telephone exchanges, starting with the Rural Automatic Exchange (RAX), developed by the Centre for Development of Telematics (C-DOT) under Sam Pitroda, around 1988. The RAX was a 100-line switch which would run in the heat and dust and tumult of the Indian village. This beat the stranglehold of a few multinationals over telecom equipment, and reduced line costs worldwide to a fraction of what they were a few years before. Indians continue to enjoy the fruits of this labour.[8] This was one of the single biggest contributions of India to the developing world. Sadly, the IITs played only a small role in this story.

Indians already spend more than $6 billion every year on tuition fees abroad. Each billion is enough to start a good university and run it for five years. Thus, the demand for a good education is indeed there and has the money to back it up. It also tells us that (i) the IITs are not getting the best students (and most likely, not the amateur engineer), and that (ii) the western university will soon open shop here in India. The second event will mean bye-bye to 'elevator' engineering for a long time. So it is really imperative for us to use our leadership position and goodwill while they last, to develop a good engineering ethos and simultaneously further the national development agenda.

In fact, the Indian society is changing in many ways. The Panchayat Raj Bill has released many democratising and developmental forces which have a distinct energy and verve about them. The Bill is posing technological problems and demanding innovative, equitable and sustainable solutions. It wants an advisor and a consultant who understands and speaks for its interests and not the interests of the state machinery, multilateral agencies or the corporation. And IITs should be the ones to move forward to this challenge.

Otherwise, we shall be mute spectators, not only to this great Indian drama, but also to our own slow demise. ∎

1. http://ieeexplore.ieee.org/xpls/abs all.jsp?arnumber=1454602
2. http://muse.jhu.edu/journals/tech/summary/050/50.4.bassett.html
3. http://www.economist.com/node/14710627
4 http://cee.stanford.edu/faculty/faculty dir.html,
5 www.cse.iitb.ac.in/_sohoni/WB-IMPACT-1997.pdf
6 http://yaleglobal.yale.edu/content/india-needs-sputnik-moment
7 http://www.education.nic.in/cd50years/f/G/BookG.htm
8. http://www.economist.com/node/18836120?story id=18836120)

Upholding the Original Mandate

■ **PROF. U. A. YAJNIK** Physics Department

Milind's article raises important issues of the relevance of IIT as an institution, its responsibility to the industry and society, its responsibility towards a large underprivileged populace and most importantly the relevance of the education and research training it imparts. The prognosis is based on obvious facts and the suggested remedies indeed seem to ameliorate these immediate issues. However, there is also an implied demand for a paradigm shift in our priorities, and this does not seem to be justified.

My comment is that there is still a cause to hold on to the original mandate. IITs were mandated to be institutions of excellence, gazers of the 'blue-sky'. But they were not meant to become such isolated ivory towers. Unfortunately, a whole category of sister institutions with variety of different mandates, (VJTI Pune, for instance) all seem to have lost their vigour and their original stature. IITs, on the other hand have remained vibrant. The decay of the other educational systems is not on account of the rise of the IITs. Funding of five or seven IITs was not so much of a burden on the exchequer that other institutions would suffer. The reasons for the latter were larger politics, demography and the choice of growth direction adopted by the industry.

Looking back now, 'Indian High-tech' seems to be an oxymoron. But that was not the way it was meant to be. During the first decades of their existence, the IITs were fully capable of providing a spurt to the high-tech surge. But the market forces, the pragmatism of the industry captains and perhaps the rapid transformation of the international high-tech sector subsequent to the arrival of semiconductors – put together, these developments dashed the vision of the Indian high-tech. It is worth noting that India's stature in sci-tech was closer to that of the west between 1880s and 1950, despite the absence of jet planes and the internet. Somehow, the optimism that closeness may have engendered did not bear out. But to actively deny ourselves that possibility again would be to forfeit the legacy of that era.

Even so, IITs have been the backbone of the concomitant developments which India espoused, such as the nuclear energy programme, the space programme, and so on. The inter-relationships between these agencies do not need to be mechanistic. Suffice to say that pursuing aerospace and satellite-based weather forecasting would be even more isolated and difficult, if a small but significant community of academic experts did not exist around the country. Likewise, it is similar with the nuclear energy industry and the basic research in nuclear science.

To become relevant to rural economy or the management of rural resources were only parts of the IIT system's mandate, but certainly not its high priority. A certain level of commitment is only to be expected, as reflected in the form of CTARA. And the scope of this response can be expanded if the need is perceived. However, the troubles faced by villages for acquiring water should not stop us from teaching or carrying out research in Fluid Mechanics and turbulence.

It is easy to deride bookishness when there is an abundance of books. Nations that do not have academies of higher learning literally thirst for their existence (as learnt personally from colleagues from smaller nations). Keeping alive at least some of the traditions of scholarship is still better than abandoning the pursuit completely.

In the IITs, we have something precious which can be easily overlooked because it is so intangible. Indeed, IITs have shown tremendous dynamism and resilience. They have taken so many changes and challenges in stride. They have indeed striven to remain relevant and are currently making the best use of the freedom enshrined in their mandate. As proposed in the article, IITs can partner with other institutions and help to revive them, but we can hardly presume to take over their unfinished mandate.

> **Nations that do not have academies of higher learning literally thirst for their existence (as learnt personally from colleagues from smaller nations). Keeping alive at least some of the traditions of scholarship is still better than abandoning the pursuit completely."**
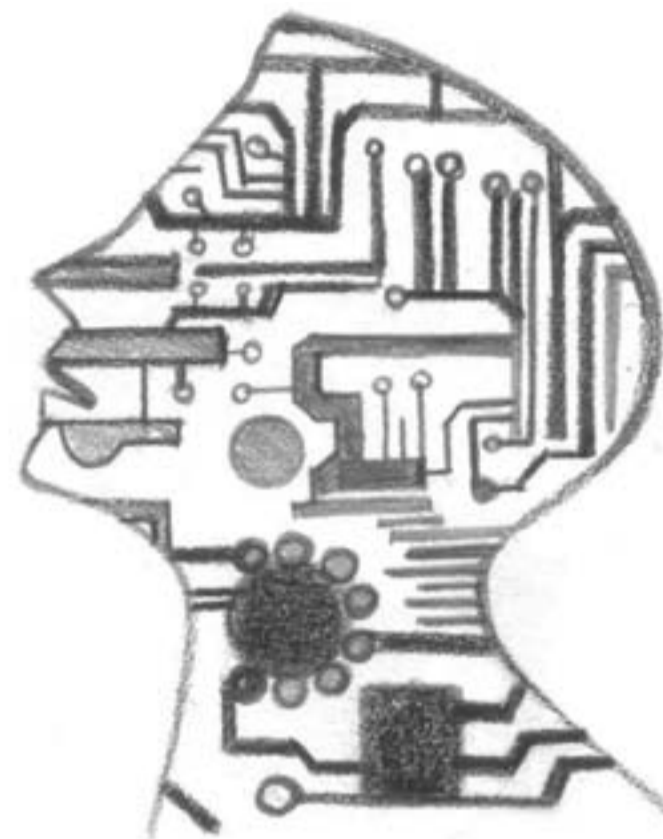

Illustration by Mugdha, IDC

What we should look towards and should lobby the decision-makers and the industry captains for, is that the rest of the academia also flourish and become autonomous and dynamic. The technologies needed for rural India perhaps require a lot of tinkering, fine tuning and proving on the ground, and not so much work in high-tech laboratories.

And this can be assisted by making science training and essential technologies available in the regular curriculum in rural areas. Indeed, the entire ecology of technical sci-tech education needs to be revived, most of all the technical training institutes.

Incidentally, this last goal is high on the activity agenda of the pan-IIT Alumni movement. IIT should resort to advocacy and to providing support to all such activities, but should not dilute its core agenda. And that is to maintain a presence on the world scene of 'higher technological institutions'. ■

Photograph by Mr. C. P. Joglekar, Coodinator (PT&D)

Brahminy Kite (*Haliastur indus*) is a distinguished looking raptor, bright rusty red above with white head, neck and breast down to abdomen. It has a rounded tail and is usually found by the river, jheel or sea coast. The bird feeds on offal, fish frogs, small snakes, bats, etc. On campus, it can be often sighted at Lakeside. ■

(Source: *The Book of Indian Birds* – Salim Ali)

The Quest for Excellence

■ **PROF. SRINIVAS ALURU** Computer Science & Engineering Department

The dichotomy between the pressing needs and problems of India and the pursuit of research excellence as measured by international standards is an oft-debated topic in IITs, government circles and in the Indian society at large. The irony of working with arguably the best and brightest faculty and students in the country in an environment with leaky apartments, inadequate access to good drinking water, poor sanitation and a road full of potholes right in front of our famed institution, is hard to miss. It is hard not to wonder if there is anything worthwhile to come out of our collective effort that can be clearly construed as useful for the nation, and make us feel proud partners in its progress. A further criticism we face is that even if our goal is research excellence by international metrics, we are far from achieving a reputation on par with the world's best universities. All this naturally leads to frequent introspection, and debates about whether a significant change of course is warranted.

The problems we face are complex, and any solutions we decide must be cognizant of the circumstances we operate in, specially those beyond our control or influence. A societal buy-in is often necessary for success. Suppose we lament the condition of our poor infrastructure and decide to educate civil and mechanical engineers, perhaps even tailor their education and research to suit Indian conditions. This plan will not work if our engineers preferred to gravitate to management education at IIMs, or abandon their field and shift to IT jobs, or if the government and society have no plans to absorb their talent.

In a democratic society such as ours, the setting up of right incentives and support structures is necessary for any plan to succeed. In developed western societies, people by and large feel assured of a decent standard of living, leaving them free to follow their passions and interests. It is all too common for Indian students and parents to seek advice on what the student must do in order to secure a certain economic future.

The irony of working with arguably the best and brightest faculty and students in the country in an environment with leaky apartments, poor sanitation and a road full of potholes right in front of our famed institution, is hard to miss.

I side with the opinion that research relevant to the Indian context should be nurtured, encouraged, recognised and rewarded. However, the choice need not be exclusionary. The deeper problem we face is not merely related to the choice of what we do, but also on how good we are at what we do and our focus on impact while pursuing our interests.

To give an extreme example, suppose as a society we decided that we would like to pursue our IT sector aggressively and were generally much less interested in educating our youngsters in building and improving civil infrastructure. This would be alright if we were world-class in the IT sector and our faculty and students were creating the most valuable intellectual property and the most valuable IT companies in the world. The resulting revenue, profits, and increase in societal wealth could be used to hire foreign experts to build our civil infrastructure, if we ourselves don't have interest in that profession. To give an analogy from the west, the decline in manufacturing and the off-shoring of manufacturing industries and jobs is often debated and lamented in the United States. However, manufactured goods are abundantly available in the United States, perhaps more so than the countries to which such industries have moved.

Research perceived as cutting-edge internationally is not necessarily irrelevant in a developing country like India.

The bigger problem we face in research and impact is that we are trailing behind the world in most everything, including in fields that we consider a priority and declare ourselves to be a success. Thus, I feel it is more important for IITs to focus on excellence, while being supportive of all forms of it (fundamental, applied, Indian context-specific, etc.). Economic development should also be considered a priority to pursue, such as through faculty incubated companies, engaging industry and offering solutions, intellectual property generation and transfer, etc.

Universities from the west are not immune to the discussion of relevance of their work to the society. Left unchecked, it is not uncommon to find faculty members focusing on a large number of incremental publications that neither advance a field fundamentally nor have any practical impact. By the same token, research perceived as cutting-edge internationally is

not necessarily irrelevant in a developing country like India. Our crop yields can be improved using biotechnology, our water problem can perhaps be solved using synthetic nano-pores. Modern biology and medicine – that are both expected to increasingly involve engineers – address the same needs that humans of all countries commonly have.

Incidentally, research targeting the societal context of developing and underdeveloped countries is both appreciated and funded in the United States, both by the government agencies and private funding organisations such as the Bill and Melinda Gates Foundation. For example, a recent R&D 100 award went to the invention of nano-pore membrane technology for water purification, with water shortage in China, India, Africa and the Middle East mentioned as the motivation for the research.[1] Biotechnology projects to improve crop yields in different environments in the world, and nutrition quality of food grains primarily consumed elsewhere are fairly common in the United States. This is because of the west's desire to have a leadership position in the world, and the confidence in monetising such intellectual property to further their economic progress.

As fairly large and premier institutes of the country, the IITs must simultaneously aspire to excel in fundamental and applied scholarship, economic development, and engagement with industry and society. Economic development, particularly leading to growth in high technology areas, is important in India to create the jobs needed to meet the aspirations of our population, which is increasingly shifting to higher education as a means to economic betterment.

A key problem limiting the progress of IITs is the lack of an incentive structure that encourages and promotes progress towards the goals. We still have an incentive structure that largely factors in age over achievements and contributions, and we have a system of expecting faculty to voluntarily contribute to institute goals while rarely assessing their performance in the context of these goals and providing feedback and correction mechanisms. Such clear articulation of goals and frequent assessment and feedback are particularly useful for young faculty recruits, who in their initial years are significantly amenable to advice on charting the course of their career. ■

1. (http://news.unm.edu/2011/07/new-membranes-for-water-purification-technology-receives-rd-100-award/).

Constructive Deconstructions: A 360° Change

■ **KRISHNA RAMKUMAR** Alumnus, B. Tech (2008)

I agree wholeheartedly with the views expressed by Prof. Sohoni in his insightful article. Here's my two pence.

In my time at IIT, I experienced first-hand the disillusionment of a large portion of the student body towards institute academics. This problem, however, has its roots in the hype surrounding the IITs. Parents and students look at an IIT degree purely as one of prestige and a gateway to a successful career. The coaching industry and the lure of the IIT brand in industry have

In the long term, the IITs need to clearly define their place in Indian society. Given the current problems facing higher education, is it the need of the hour to be a purely technical institute?

only fuelled this hype. In high school, very few students take the time to explore their real interests. Pursuing anything less than science is considered inferior by a large majority of our society. Invariably, the brightest students prepare for JEE.

When this pool of high-achieving, driven students enters IIT, it suddenly feels like they have attained their lifelong goal. They struggle to come to terms with what to make of their IIT education. Most land up in disciplines by virtue of their JEE rank and not interest. They then begin to lose motivation, become disillusioned and go through college life with the sole aim of netting a top job.

To address this problem, I believe crucial changes are required in the IIT system both in the long term and the short term. In the long term, the IITs need to clearly define their place in Indian society. Given the current problems facing higher education, is it the need of the hour to be a purely technical institute? Today's intake
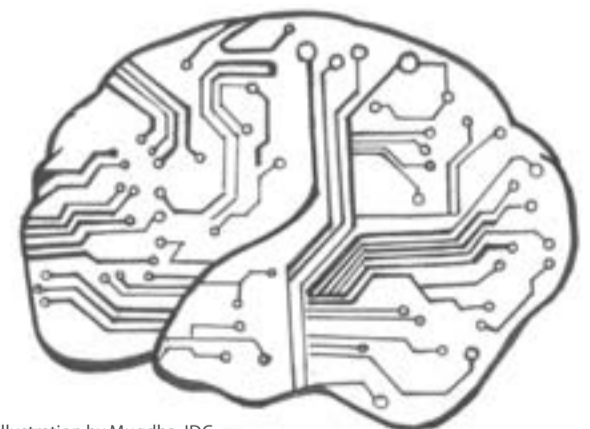
Illustration by Mugdha, IDC

is of smart and highly motivated students with a large variety of interests. Hence, the IITs need to create avenues to pursue varied interests, in the form of medical schools, strong social science departments and good business schools. Students can then be given the freedom as well as the resources to explore their interests.

Admittedly, this approach would require a complete overhaul of the current system with multiple stake-holders joining hands. But to my mind, this is the only way for the IIT brand to deliver what is perceived of it.

In the short to medium term, under the existing mandate of creating a world-class technical institute, I think three big improvements are needed in the system.

First, IIT needs to create an institutional framework for interaction with industry. This can be in the form of guest lectures by industry stalwarts or collaborative research through projects and summer internships. Engaging with industry leaders across engineering streams will help students identify key current challenges in various domains. Through internship opportunities, students can explore their interests and build practical problem solving skills. In sharp contrast to the IITs, institutes such as MIT have a large volume of industry interaction. Closer to home, even universities like IIM Ahmedabad encourage students to take up consulting assignments with local industries.

Second, there needs to be a greater degree of academic flexibility. This gap has been partly bridged through initiatives such as the major-minor degree. However, a lot can still be done to improve the interdisciplinary nature of courses. Moreover, several courses need to be re-designed to move the focus from textbook learning to application-oriented learning.

Third, the entire IIT ecosystem needs to make a concerted effort to encourage innovation and entrepreneurship. As a group, IIT professors should take on a leadership role by defining key problems at the forefront of industry. Students should in turn spend more time working on these problems and interacting with industry professionals to broaden their knowledge. Well-designed courses, competitions and technical mentoring programmes can also help in creating an entrepreneurial climate. ∎

ET CETERA | Altu-ering and Faltu-ering

■ **BAKUL DESAI**, Alumnus, B. Tech. (1982)

Raintree Correspondent (RTC): Prof Altu! Can you tell us about your research work?
Prof. Altu (PA): Yes. I am currently working on developing a field called Tadipology.

RTC: What is tadipology?
PA: It is a broad-based platform that will facilitate the integration between Poronsis and Catipilia.

RTC: Huh? What is Poronsis? What is Catipilia? Please remember that this is an interview in English.
PA: My colleague Prof. Faltu here is researching Poronsis and he can expand on that.
Prof. Faltu (PF): Yes, I can. You see, when Poronsis ultimately delivers on its objectives, it will need to interface with environments that are consistent across research platforms all over the world, and that is why we need to develop Tadipology first as a starting point before connecting with Catipilia. Only then, can we go live and global with our output.

RTC: But I don't understand! I still don't know all these terms mean. What is going to be the final outcome of all this? What is the end product? Are we going to see a cloned cat? A toxic chemical? Eiffel Tower? Bombs? Garden hoses? What?
PA: Let me give you an example. If I had told you 25 years ago that I was researching modems and USB ports before the computers came in, would it have made sense? But had we invented modems first in anticipation of the new generation computers, we could have had internet much earlier, right? Similarly, I'm researching Tadipology in anticipation of someone taking up development of Catipilia. In fact, I am looking for someone to research Catipilia. Can you send a message out through *Raintree*?

RTC: Prof. Altu! I am perplexed. How can you research and invent something in anticipation of something which has not even started? Isn't it like building castles in the air?
PA: Your concept of buildings is outdated. Nobody builds castles nowadays. This is an age of flyovers. We build something in the middle. Others build lampposts above the flyovers and slums below. That is what we are doing – creating a research platform for someone to develop above and below.

RTC: I am still lost. I still haven't figured where this will lead us and what we will see at the end of your research.
PA: Okay, let me explain. Someone researched enthalpy and entropy. Do you know what they mean?

Illustration by Utkarsh Raut, Second Year Mechanical Engineering

RTC: I have lived in a hostel room, so I know what entropy means. I don't know about enthalpy.
PA: You know the English definition of entropy, not the scientific one. Even thermo-dynamists don't know exactly what enthalpy means. But they still researched it and created a full course for it, didn't they? For that matter, would you have known about gravity and understood it before the apple fell on Newton's head?
PF: Speaking of Newton, I need to tell you that the apple was crucial in discovering the notion of gravity. The credit should go to the apple and not Newton. Can you imagine what would have happened if Newton sat under a coconut tree?

RTC: Maybe the coconut would have fallen and Newton would have still discovered gravity.
PF: Wrong! That's why you do not understand research concepts. Had a coconut fallen on Newton's head, he would have been knocked out cold and he would then have discovered a bandaged forehead and not gravity. Apple was the key in this discovery. Actually, the apple led to the procreation of the human race as Adam will tell you.

RTC: This is bizarre. Please help me understand what you are researching.
PA: I think we'll hold back on telling you more. Sometimes, people steal each other's research ideas and pass them off as their own. That's what happened with the wireless.

RTC: Someone stole the credit for wireless discovery? You mean Thomas Edison?
PF: Precisely. You see, back in early eighties, B. J. Hamilton was our Estate Manager. He asked his assistant Vishnu to bring him 20 wires. When Vishnu got the wires, Hamilton counted them and found only 19. So he shouted, "I have discovered a wire less." So the wireless was discovered by Hamilton, not Edison.

RTC: Okay, Professors Altu and Faltu. Since you won't tell me anything about your Tadipology and Poronsis and Catipilia, will you at least tell me what will happen if you do not discover whatever you're trying to? I have stopped trying to discover what you're attempting.
PA: If we do not discover any of these new age futuristic technologies, we will get our PhDs.

RTC: How's that?
PF: Some professors have spent many years passing Chlorine gas at high pressure over a surface of soiled marbles heated to 80 degrees in a SS-lined kiln using copper sulphate crystals as a catalyst and recorded readings taken over 32 minutes of this operation.

RTC: So?
PF: Nothing happened and these professors recorded this whole experiment and their research process in fat reports to report that nothing happened with all this in the end.

RTC: How's that connected with you getting PhDs?
PA: You really don't understand research. You have to spend many years to show that nothing can happen most of the time, despite trying hard. These professors are given PhDs for being able to turn out nothing from their experiments. It's not easy to stay inert and non-reactive under such trying conditions.
PF: We're working on Tadipology and Poronsis and looking for an ally to work on Catipilia in the hope that nothing will come out of all this and we can get our PhDs in the process. ∎
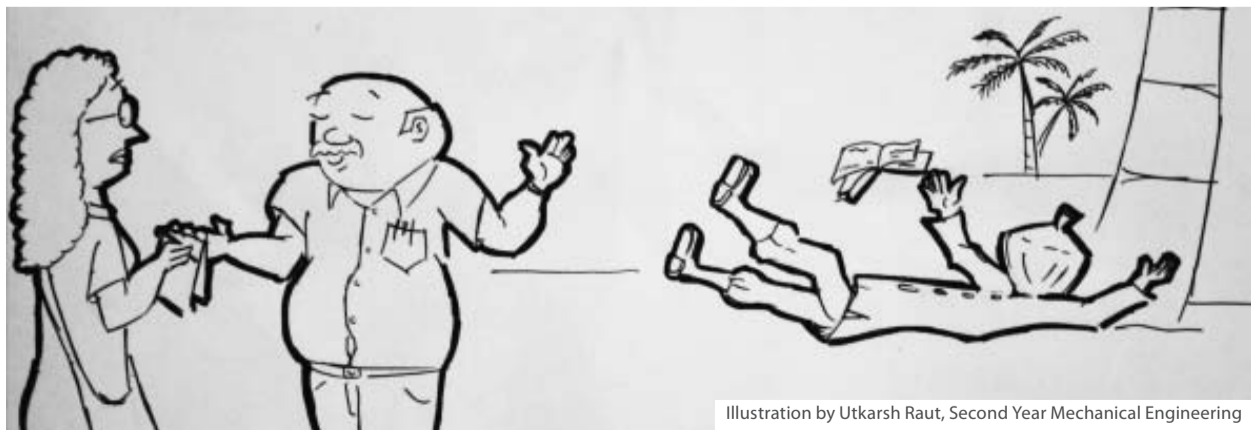

Illustration by Utkarsh Raut, Second Year Mechanical Engineering

The Importance of Stupidity in Scientific Research

■ *Below are excerpts from a blog post written by* **DR MARTIN A. SCHWARTZ** University of Virginia, USA

I recently saw an old friend for the first time in many years. We had been PhD students at the same time, both studying science, although in different areas. She later dropped out of graduate school, went to Harvard Law School and is now a senior lawyer for a major environmental organisation. At some point, the conversation turned to why she had left graduate school. To my utter astonishment, she said it was because it made her feel stupid. After a couple of years of feeling stupid every day, she was ready to do something else.

I had thought of her as one of the brightest people I knew and her subsequent career supports that view. What she said bothered me. I kept thinking about it; sometime the next day, it hit me. Science makes me feel stupid too. It's just that I've gotten used to it. I'm so used to it, in fact, that I actively seek out new opportunities to feel stupid. I wouldn't know what to do without that feeling. I even think it's supposed to be this way. Let me explain.

For almost all of us, one of the reasons that we liked science in high school and college is that we were good at it. That can't be the only reason – fascination with understanding the physical world and an emotional need to discover new things has to enter into it too. But high-school and college science means taking courses, and doing well in courses means getting the right answers on tests. If you know those answers, you do well and get to feel smart.

A PhD, in which you have to do a research project, is a whole different thing. For me, it was a daunting task. How could I possibly frame the questions that would lead to significant discoveries; design and interpret an experiment so that the conclusions were absolutely convincing; foresee difficulties and see ways around them, or, failing that, solve them when they occurred? My PhD project was somewhat interdisciplinary and, for a while, whenever I ran into a problem, I pestered the faculty in my department who were experts in the various disciplines that I needed. I remember the day when Henry Taube (who won the Nobel Prize two years later) told me he didn't know how to solve the problem I was having in his area. I was a third-year graduate student and I figured that Taube knew about a 1,000 times more than I did (conservative estimate). If he didn't have the answer, nobody did.

That's when it hit me: nobody did. That's why it was a research problem. And being my research problem, it was up to me to solve it. Once I faced that fact, I solved the problem in a couple of days. (It wasn't really very

Illustration by Ankita Roy, IDC

hard; I just had to try a few things.) The crucial lesson was that the scope of things I didn't know wasn't merely vast; it was, for all practical purposes, infinite. That realisation, instead of being discouraging, was liberating. If our ignorance is infinite, the only possible course of action is to muddle through as best we can.

I'd like to suggest that our PhD programs often do students a disservice in two ways. First, I don't think students are made to understand how hard it is to do research. And how very, very hard it is to do important research. It's a lot harder than taking even very demanding courses. What makes it difficult is that research is immersion in the unknown. We just don't know what we're doing. We can't be sure whether we're asking the right question or doing the right experiment until we get the answer or the result. Admittedly, science is made harder by competition for grants and space in top journals. But apart from all of that, doing significant research is intrinsically hard and changing departmental, institutional or national policies will not succeed in lessening its intrinsic difficulty.

Second, we don't do a good enough job of teaching our students how to be productively stupid – that is, if we don't feel stupid it means we're not really trying. I'm not talking about 'relative stupidity', in which the other students in the class actually read the material, think about it and ace the exam, whereas you don't. I'm also not talking about bright people who might be working

in areas that don't match their talents. Science involves confronting our 'absolute stupidity'. That kind of stupidity is an existential fact, inherent in our efforts to push our way into the unknown. Preliminary and thesis exams have the right idea when the faculty committee pushes them until the student starts getting the answers wrong or gives up and says, 'I don't know'. The point of the exam isn't to see if the student gets all the answers right. If they do, it's the faculty who failed the exam. The point is to identify the student's weaknesses, partly to see where they need to invest some effort and partly to see whether the student's knowledge fails at a sufficiently high level that they are ready to take on a research project.

Productive stupidity means being ignorant by choice. Focusing on important questions puts us in the awkward position of being ignorant. One of the beautiful things about science is that it allows us to bumble along, getting it wrong time after time, and feel perfectly fine as long as we learn something each time. No doubt, this can be difficult for students who are accustomed to getting the answers right. No doubt, reasonable levels of confidence and emotional resilience help, but I think scientific education might do more to ease what is a very big transition: from learning what other people once discovered to making your own discoveries. The more comfortable we become with being stupid, the deeper we will wade into the unknown and the more likely we are to make big discoveries. ■

A Definite Maybe, Minister!   ■ **DHAVAL DALAL** Alumnus, B. Tech. (1985)

The minister of environment enters his office at Jantar Mantar in a huff. He summons his permanent secretary, Shri Harish Chandra (HC), and his private secretary, Shri Badrinath Doraiswamy (BD), to the Situation Room – the atmosphere is tense, but keen observers would detect a smirk on HC's face.

Minister: I am coming from a meeting with the High Command. I have been tasked to upgrade the research environment at IITs in the next six months.
HC: Interesting development, minister. I wouldn't think it has anything to do with your comments about poor quality of research at IITs.
Minister: I was just being candid with the media!
BD: Sir, with all due respect, you lost your right to be candid the date you became a candidate.
Minister: But who knew being forthright with the Fourth Estate would be worse than third degree with the Third Reich? Anyway, what do you suggest I should do?
HC: Have you thought about setting up a task force?
Minister: Yes, but they want me to provide some specific steps for the improvement of R&D.
HC: Surely they must be out of their minds! Governance is not about providing specific steps, it is about providing sound bites to the media.
BD: Sir, we can look at some metrics for the R&D output.
Minister: But there are all kinds of R&D – R&D, R&d, r&D, r&d… What are we going to measure?
HC: May I suggest that we look at measuring the research papers published by the

Illustration by Utkarsh Raut, Second Year Mechanical Engineering

IIT faculty and students? We can easily show a growth in this output by publishing new government R&D journals and making it compulsory for the faculty to publish in these journals. We will even waive the requirement to have previously non-published material only.

BD: But what about the quality of these papers?

HC: My dear BD, quality of research is like beauty – it lies in the eye of the beholder. As long as we in the government retain the exclusive rights to behold and judge the R&D of the IITs, we will do fine for the people.

Illustration by Utkarsh Raut, Second Year Mechanical Engineering

My dear BD, quality of research is like beauty – it lies in the eye of the beholder.

Minister: And for ourselves, I assume. But what I had in mind was the research that benefits the industry in some tangible way.

HC: Sir, it is not our job to tamper with the market forces that drive the decisions of the private industries on how to allocate their resources.

BD: But in many countries, companies often spend more than 10% of their budgets on R&D and engage with universities in a very proactive and productive way.

HC: In our country, the market demands are a bit different. We require the same level of resources to be used in IB.

Minister: Where does Intelligence Bureau enter into the picture?

BD: No sir, Shri HC is talking about Inducements and Bribes.

HC: Would you like to suggest to the High Command that they publicly advocate redirecting the IB budget to R&D?

Minister: Yes, of course!

(BD whispers in the Minister's ears)

Minister: I was speaking hypothetically, of course. In a democracy, the will of the people and the will of the market are indistinguishable. The idea is good, but time is not ripe, so I would not like to rock the boat, so to speak.

HC: So, do we agree to set up an empowered committee to increase the research paper output of the IIT professors?

BD: Yes, and perhaps add the patent filings to the list to make it look like we are serious about it.

Minister: OK. But just between us, what do you think is the biggest factor in limiting the research output of the IITs?

BD and HC: It's the environment, minister! ∎

In a Quiet Little Corner of Never-Never Land

■ **HARSHVEER JAIN** 2nd Year Undergraduate, Engineering Physics Department

A lot of places in IIT Bombay boast of the qualities that I am about to mention. But this little abandoned hut that hides behind a lush patch of trees and grass will always hold a special place in my heart.

The IIT Bombay boathouse, now no more a boating getaway, is a secluded spot of beauty and quietude. And I need not mention all the attributes it attaches itself with. It can cater to all romantic needs, be it of a poet or a lover. It can provide all the calm and quiet a mind requires, and all the activity and life a heart yearns for. And it can prove to be quite charmingly helpful when one needs to show off the institute – like I did.

It was during Mood Indigo last year that I first set foot on the narrow trail that leads to the Boat house through the green-roofed walkway behind H8. And man, did I have company. I might have had to fake a story to sell my article, but this piece of paper holds in it a true story, my friend; a story that would seem sweeter than fiction to someone who understands the plight of the common IITB boy.

I was guiding a bunch of pretty young ladies from Bangalore into the heart of wilderness. Every sound, from that of a stick breaking the surface of one of the little pools of water that surround the pagdandi or a random animal or bird using their vocal chords, would spook a couple of those beauties. Being the sole male in the group (I'm not trying to be a sexist here, just honest) I was either being held by the shoulders or closed in by the girls. Trust me, I had never appreciated the importance of wildlife more.

Once there, every single one of us was lost in the beauty of the lake. This is saying something. If something is preferred over a group of elite females, it's got to be good. And good it was. 'Brilliant, amazing, breath-taking' – choose whatever adjective you may, but it will fail to describe the feelings you feel, when the water falls on the surface of the lake and you are standing on a little island-like place, surrounded by water all around. When the raindrops hit the surface, the lake appears to be boiling, the water dancing around. The wind that blows here brings with it a coolness that refreshes and the horizon; where the sky

It can provide all the calm and quiet a mind requires, and all the activity and life a heart yearns for. And it can prove to be quite charmingly helpful when one needs to show off the institute.

merges with the water, flowing like watery ink into the surface of the lake mesmerises the senses, teasing you to jump in and take a dip.

It is a small place in this large campus. It is but a minor piece of abandoned land that the wild has claimed. But it is worth more than a visit. It is worth every careful step you take on the muddy trickle of stoned land. And it definitely deserves a date with the inmates of the institute. Take out some time in this season. Look out for the big cats, but trust me, the risk and the adventure make it more unique. And when you do get there, close your eyes, open your arms wide and take a deep breath in the fresh air. You will – if only for a moment – feel high, legally. ∎

Near Boat house, Lakeside
Photo by Regan Raj, IDC

Near Boat house, Lakeside
Photo by Regan Raj, IDC

History revisited

■ **ROHIT MANCHANDA** (Biosciences & Bioengineering Department) in an interview with **(late) PROF. KARTIC CHANDRA KHILAR** (Chemical Engineering Department) and **PROF. KRITHI RAMAMRITHAM** (Computer Science & Engineering Department)

The IITs have always had teaching as well as research as its twin mandates. In IIT Bombay, both have been pursued hand-in-hand right from the days of its inception. However, while earlier IITB was known primarily as a world-class centre of engineering education, in recent times there has been an intensification of focus and efforts to aspire to be a world-class centre of Research and Development as well. Much of this concerted focus on R&D has come about in the last decade or so. In this segment, we take a more historical approach to the issue of R&D and present to you excerpts from an informal, free-wheeling discussion between two of our past Dean R&Ds, the late Prof. Kartic Chandra Khilar and Prof. Krithi Ramamritham. Both were jointly interviewed by Prof. Rohit Manchanda extensively, while researching for his book, Monastery, Sanctuary, Laboratory: 50 Years of IIT Bombay. We hope it serves not just as an interesting read but also as an excellent reference point to take stock of how far we have come on the R&D front, so that we can better understand the direction that we need to move forward in, in the future.

Introduction by **DAMAYANTI BHATTACHARYA**

Rohit Manchanda (RM): Prof. Khilar, you took over as Dean R&D in 2003 and this was at a juncture when Research and Development (R&D) was being empha-sised upon more and more at IIT Bombay. When you took over, what did you perceive as the strengths and weaknesses for R&D at IITB?
Kartic Khilar (KK): When Rangan (Bannerjee) and I came into that office, things were in great shape. Prof. Suryanarayan and Prof. Kannan had started a number of very good initiatives; the online transaction was underway and greatly helpful to faculty members. Prof. Suryanarayan had started Intellectual Property patenting and IP management, which were both pick-ing up and he was also considering incubation and entrepreneurship, which eventually became SINE. So there were lot of initiatives in the anvil already.

One of the major concerns I had was that I was not happy with R&D output from IITB even on standard productivity parameters, such as number of papers per faculty, per year and number of patents, collabora-tive efforts or technologies developed here that had the potential to have a significant impact, be it on the industry or the society. Both of us felt that if IITB was going to be known as a leading research intensive uni-versity in the world, then we certainly had to enhance our R&D output, both in quality as well as quantity.

The key to improving R&D output in our opinion were the faculty – if faculty members are motivated, and are given proper resources they will attract very good students. They can be instrumental in developing good

facilities for R&D activities and hopefully, the output will show itself eventually. So for Prof. Rangan and me, our entire approach was faculty-centric. We told ourselves, "let's just devise ways, means and schemes to motivate faculty members". Prof. Suri had started reviewing the CPRN, i.e. the Consultancy Practice Rules and Norms and one of the first things we decided to do was to make it entirely faculty-friendly. I think we have a faculty-friendly CPRN right now. After that, we focused on RDF (Research Development Fund) as a way to empower faculty member and facilitate R&D activities.

RM: If I may come to Prof. Ramamritham now, you, of course are a relatively recent addition to the institute and within rapid time, became the Dean R&D. I would really like to know how you view IITB as an institute for research and development at the time when you joined. What were your impressions just before you came here and then in the first, let's say, couple of years after you joined?

Krithi Ramamritham (KR): I decided to join IITB after a lot of research. In fact in 1994–95, I spent an entire year in India doing the rounds of all the IIT campuses and IISc, plus a lot of laboratories. From my initial impressions, IITB came across as a place very different from the others. It seemed like a place where people were willing to think out of the box and there was a lot of proactive willingness on the part of the admin-istration and in faculty. For instance, a refrain I heard in many places was that something cannot be done because it had not been done before at IITB. When I asked people here, "can we do this?" IITB responded by saying, "if you want to try it, we can try it". So that gave a very positive impression of the place to me.

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RM: What was your impression of the research output at IITB?
KR: In fact, it was surprising to me that the impression I got was that there is a lot more that is possible here. It was apparent then, and I think fortunately or unfortu-nately, it still holds true even today. What I mean to say is that there is a lot more hidden talent, hidden potential, hidden capabilities that we need to somehow bring out of the community. It might be due the fact that I had just come back after spending about 20 years in US and one
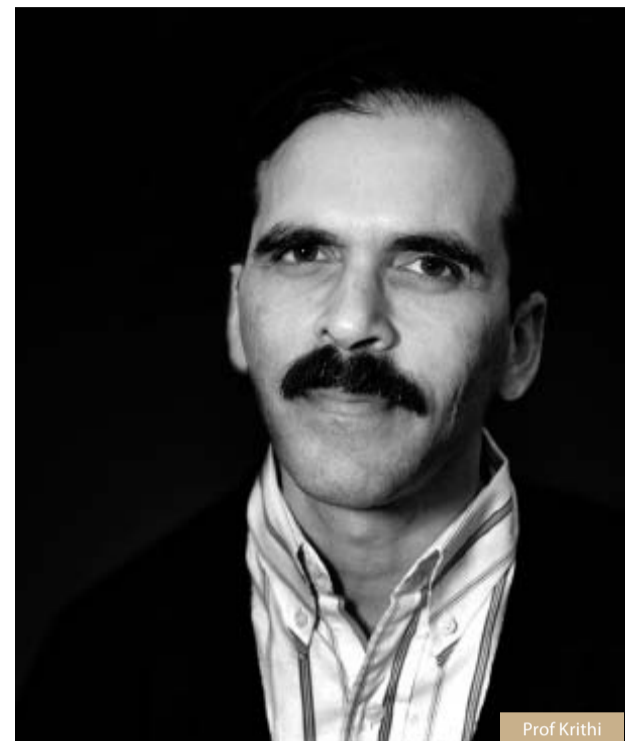
Prof Krithi

deficiency that I noticed was the multiplication factor in terms of the amount of time that faculty members put into research and the productivity output.

It's true that the faculty here do a lot more hand-work in terms of research and also support work – running machines, writing programmes – as compared to a western researcher. The support systems here are not at par with what you would find even in a middle-class university in the US. It is also true that due to the changes in the UG curriculum, our advising load has also become very large. So we have a situation where one has to learn how to make all of this work and still do your research. Having said that, in the US, you do research first and then the other stuff later, here we do the other stuff first and then research later.

RM: Prof. Ramamritham says that as a faculty member, you end up spending a lot more time on other things. Do you think things have changed over the last ten years or so, in terms of ease with which the productiv-ity can be attained? I mean, I know we still have to go a long distance to go, but even then…
KR: A couple of things are happening. One of them is that people are beginning to see the benefits of having their own research grants. They give a lot of flexibility in how you manage your time. You can employ people to do the work specially if it is more mundane; what I call as manufacturing-style work. Thinking can be done by the faculty member. Secondly, I think the presence of funds such as RDF and DDF is giving people extra flexibility, and we have only made things much more open.

It is much easier for people to spend these funds in legal ways. As long as it is acceptable, and something related to research, we let them spend it. These things are help-ing our cause and the third phenomenon is that the insti-tute at large is seeing the benefit of coordinated research, collaborative research. The Institute Strategy Planning Committee (ISPC) has come up with a number of schemes, all of which are pushing people to think about collaboration. You know, two plus two is not simply four anymore, it can be forty. And once the faculty members decide to collaborate, students will get the message.

RM: Are there any possible pitfalls in the western model that we should be careful to avoid, and reasons why we should also be careful to not accord it too much importance?
KR: One thing that immediately comes to my mind is the focus on funding that the western model demands of a faculty member. It is used to measure your research productivity which contributes, in many cases, to a larger publication list and so forth. But this situation also makes you think about funding first and then next, what is closer to your heart. It has both pluses and minuses.

Prof. Khilar

Since we have to keep pace with the times and are continuously looking for opportunities to expand the horizons of the applications which emerge from our research, we need to be on our toes all the time. So you are an entrepreneur, not in the commercial sense of the word, but in terms of thinking new things, exploratory things. That's the positive part of it.

The downside is that you can't take long-term projects, and solve them, the way we can do here. For us the downside is that because there is no pressure for funding, one can be solving a long-term problem and tend to slack off. How do we get the best of both worlds? We'll have to come up with an interesting combination and I am sure we will do that.

It's true that the faculty here do a lot more hand-work in terms of research and support work as compared to a western researcher. The support systems here are not at par with what you would find in the US.

RM: Your thoughts on this, Prof. Khilar? What could be that combination?
KK: If we simply compare the resources that a faculty member in an American university has and a faculty member at IITB has, there is a great difference. First of all, they get bright graduate students and their infrastructure is really good. They have a competitive environment and there are also market forces. We don't have those. This is probably both good and bad.

I would think that we should try to attract good graduate students. Once we have that, I think we are really better off in a way because we don't have to deal with market forces. I have feeling you can do better quality research.

RM: Now that brings us to a point of quite deep concern, which I think has exercised us all these years. When we speak of attracting the best graduate students, we believe that they could be our own graduates, but they never stay. So what is the secret to attracting them to stay on?
KK: We have to compete with other universities. There is no other way; we just have to compete with our counter parts. That's the way I think.

KR: One aspect is that we have to compete. But I also think that we have to be a bit more visible in what we do, and I mean two things from that. See, many of our students are in fact in Indian companies, in research laboratories and doing great things. We haven't taken the time to see how many are there, what they are doing there. How do they impact their companies, either dir-ectly or indirectly? We only have anecdotes about these achieve-ments. We haven't, for example, compiled this in a very methodical way. And secondly, the opportunities that we offer here, we should speak about them by going to colleges which house these bright students, and tell them

that you don't have to go abroad to be working with GEE or GM or Microsoft or TCS or wherever the opportunities lie, you can do them here. This is a good advantage that we have, because a senior faculty member in the US won't have any time at all to directly help a student come up to speed. You know, solve a problem with him or her, here we do that. If somebody is interested in research then they can, they will find the time here.

In the US, there is an hierarchy. Postdocs after professors, then PhD students, Masters students and so on. This hierarchy speaks. You very rarely get a chance to talk to a professor.

Here, you can offer more intellectual capital. So we need to do a fair amount of publicity for the capabilities or the opportunities that exist right here. The good news is that the trend is also changing. To give you a very recent example, when the Computer Science depart-ment recruited PhD students this year, out of about 50 plus applications, about 15 were from IIT students and finally, about a dozen or so were selected. Of these, nine I believe are IIT students; not IITB alone, all IITs, including a couple of B. Techs. It's a good sign; it is a heartening sign.

We don't have any research intensification events. For example, we don't have domain discussion dinners; we don't have groups brought together by the Director or Deputy Director to talk about research projects. Most of the time, we are busy in meetings with the delegates, who come and show us their R&D presentations, and things like that. So I may be a little pessimistic on this note.

Instead, we need to focus on intensifying the research atmosphere of our institute. When a young faculty member joins, he or she should immediately perceive a number of role models who are really serious about research. That being here is an opportunity for them to solve some significant problems.

We need to focus on intensifying the research atmosphere of our institute. When a young faculty member joins, he or she should immediately perceive a number of role models who are really serious about research.

RM: That's an interesting point. I have a feeling one get the sense that IITB is a state of transition – perhaps from being an institute renowned for its teaching – to at least aiming to be renowned for its research work. But I think that during this transition a kind of schizo-phrenia comes in. The flip side is that there is one school of opinion which says that with this stress on R&D, young faculty members are often single-minded about research taking away from some of their teach-ing functions. How do you feel about that? Have you come across that opinion?
KR: Somewhere down the line, I think our departments too may have a culture that can be limiting. Some of the

There are always nay-sayers to any idea but sometimes you have to take a risk. Unless you take risks, you cannot go forward.

collaboration issues faced by departments are of domain dependence, so we can't do much about it as an institu-tion. But we are different. We have to be IITB; we can't be Chemical Engineers first and then IITB researchers afterwards. Actually in the Governance Committee, we had discussed a possible road map where departments would exist for looking after the academic, teaching part of our work, whereas research would be more non-department specific, because most of the interesting and challenging problems are cross-disciplinary. I think a model has to be evolved on these lines.

There are some places where colleges control R&D funds. That college could be an engineering college, a science college, a college of humanities, a college of medicines, and so on. The person in charge con-trols the purse meant for the college's R&D activities, pertaining to a specific department. I think we need to look at that system as a model.

KK: Often the Heads are bogged down by adminis-tration and lose sight of a more leadership-oriented, visionary role. Prof. Phatak was a good at this. Even as a Department Head in Computer Science – before he started the school of IT – he took some initiatives which I am sure did not have the popular consensus of the whole department. But he had a certain vision, so he pushed forward and you know, the benefits of his persistence are there today for all to see. I am sure, even today people refer to some of the decisions that he made, which had long-term impact for the depart-ment and the institute. We need emulate this in other departments. There are always nay-sayers to any idea but sometimes you have to take a risk. Unless you take such risks, you cannot go forward.

KR: There is an interesting development which is sort of harmful. When I came here ten years ago, in Computer Science, about one-third of the class would apply to go abroad. This meant that they were inter-ested in doing their Masters. They had to have a good credit point average, good recommendations and so they worked towards that. Now, those numbers have decreased enormously. Companies hire them because they are the IIT products. Whatever little pressure that they had – that half or one-third of the class had to perform well – has disappeared, or has reduced to one-fourth of the class or less now. This means that unless they are intrinsically interested in pursuing this domain, they won't be motivated. Currently, many of them don't study for reasons that we know about. They are not going to be taking out extra time to per-form better and contribute to research. The number of students that I had before, who were world-class, with whom we were happy to sit and spend time with – even if they had to be trained for a long time – has decreased enormously. ∎

Making Waves above the Water ∎ BHAVINI PANT Campus Resident

If you have ever learnt swimming from Dr Reddy, you'll join me in wondering if he has ever taken a dip into the waters himself.

Almost three decades ago, before he got 'Dr' prefixed to his name,'Reddy Sir' was blazing his school grounds with a talent for athletics, table-tennis, kabaddi, kho-kho and opening cricket matches with his fast bowling. He had got admission to study engineering at Visvesvaraya College in Bangalore, but decided to live his pas-sion instead, and went to study Physical Education at Laxmibai National College of Physical Education, Gwalior. It was here, Dr Reddy reveals, that he learnt swimming for the first time. Convinced that Reddy had a gift, his guide suggested he take up swimming as his specialisation.

After completing a diploma in Sports Coaching from NIS Patiala, Dr Reddy joined IITB as a Coach in 1983

– the same year that India won the World Cup in cricket for the first time. Recalling the first summer swimming camp he organised, he reels off names of many senior faculty members, and describes how he helped the women overcome their initial hesitation to learn from him. "After that first camp," he says, "its popularity shot up. Now, we have seats filling up within moments of sending out the official email notice."

If you're someone who likes talking in numbers, Dr Reddy's statistics sound like a song by Rammstein (a German Industrial Metal band). A national coach for four years and a state coach for six, Dr Reddy has been training swimmers for the state-level Junior and Sub-Junior tournaments, and the Asian Games as well. Under him, IITB has seen 25 National Champions, six of whom have represented India internationally. IITB has also won 20 of the 25 Inter-IIT championships in

swimming to date, under his mentorship.

Dr Reddy is one of the few (and perhaps only) sports coaches across India who has done a PhD on training methods for swimming. He talks about his teaching strategies in detail. "When I first began swimming camps in 1984, they'd go on for a month. Over time I researched the effectiveness of different teaching methods that I'd use on my students, and finally man-aged to shorten it to 15 days. That's how long they've been for the past 10 years. Now, 50% of my students complete the beginner's endurance test of swimming a kilometre in an hour," he says.

As the popularity of the summer swimming camps grew, Dr Reddy initiated swimathons, triathlons (swim-ming-cycling-running) and his favourite, the Swimming Gala, all inspired by his own activities while in college.

The swimathon requires its participants to keep swimming or floating in the pool for 12 hours. Dr Reddy seems to possess a particular fondness for endurance tests, as his eyes light up at the mention of a similar but vastly more challenging event called the Swimming Gala. It was introduced with the idea of allowing swimming champions in the institute to compete with swimmers from outside, since it was difficult for students to make time to leave the campus and participate outside. He recalls a particularly dazzling Swimming Gala in 1997, when two of his former students, (Ashish Singhvi and Neil D'Souza, aged 19 and 12 then) stayed in the pool for 85 hours straight, setting a national record.

It was also an occasion to showcase theatrical swimming – swimmers would delight the audience by performing feats like covering the entire length of the pool underwater, or swimming in peculiar strokes – I fondly recall the 'chicken stroke'. Discontinued after 2008 due to administrative reasons, Dr Reddy now focuses on a variety of competitions and coaching his students.

Apart from swimming, Dr Reddy also manages the coaching, events and administration of tennis on the campus, which include running beginner's camps and supervising competitions.He is responsible for grooming institute teams for both girls and boys in swimming, tennis and water-polo, in addition to overseeing pool maintenance and administrative duties. With the new pool about to be opened early this September, Dr Reddy only sees himself further occupied. He adds modestly, "I look forward to the institute authorities appointing a coaching assistant, so that I can give our teams and other learners adequate personal attention."

Swimming Gala was also an occasion to showcase theatrical swimming – swimmers would delight the audience by performing feats like covering the entire length of the pool underwater, or swimming in peculiar strokes.

He has ambitious plans to develop the new swimming pool. These plans include having a fitness centre where swimmers can do basic weight training and aerobic exercises before jumping into the water.

National champions notwithstanding, Dr Reddy presents an intriguing picture of passionate zeal and zen-like positivity. "I've also proposed a steam bath and sauna bath in the pool premises, where our swimmers can relax

Dr Reddy with his students

and unwind after a hard day." Hear, hear. When asked if there has been any change over the years, among his students or in the institute's attitude towards sports, he says, "Students, residents and faculty members have only become more enthusiastic. At times, I'm beleaguered by requests to start new beginner's camps. The interest in swimming has risen tremendously and sometimes, it is difficult to match it with adequate efforts and initiatives." And what of the institute? "There has been a gradual decline in their interest, but they have been very generous with providing the new 50 metre swimming pool. The number of people wanting to learn swimming is rising rapidly, so dedicating a pool for serious swimmers is an imperative step forward in ensuring all-round development."

Something that sets Dr Reddy apart is his bottomless capacities for motivation. His students remember him for his unending, unstoppable encouragement, which has the power to transform any clumsy, heavy, sinking body into a seamless, fearless body in love with being inside water. His student profile is colourfully diverse but his aim is uniform for all of them: that you combine fitness and delight while swimming.

He describes a particular teaching technique called the 'Survival Jump' with an expression of kindness and glee in his eyes. This jump involves diving from a five metre

His student profile is colourfully diverse but his aim is uniform for all of them: that you combine fitness and delight while swimming.

high platform, swimming to the edge of the pool and pulling yourself out. He explains that this is crucial to overcome hydrophobia, and I agree with him from personal experience. He recounts how he has had countless students who have had great difficulties with this exercise, how he has helped them overcome their fears, and how these very students eventually can't keep away from swimming for too long. It isn't really his impeccable numbers or records which define him – it's this. ■

Beginner's Camp (Endurance test: 1 kmph)	Intermediate Level I (Endurance test: 1 hour continuous swimming)
KabirRao Deb	Ishan Juneja
Pranshu Kumar	Ankur Sahoo
Gunjan Phale	Mrs. Shelet Fernandes
Yash Soman	Soham Sharma
Sohan Sharma	Arushi V. Denuka
Sashwat Prasad	Pranshu Kumar
Ananya Chandorkar	Intermediate Level II (Endurance test: 1 hour continuous swimming)
Meenakshi Mikherji	
Shubham Jangid	
Kanishka Sunick	
Mrs. Minisha Rao Deb	
Monalisa Malick	Rajarshi Samajdar
Pushkar Kothaode	Chaitanya Varekar
Shashwat Shukla	Pavan Chandiramani
Shashank Chandrashekhar	

IITB's R&D: Hopes, Fears and Dreams

■ **SURINDER PAL SINGH** 2nd Year M.Mgmnt., Shailesh J. Mehta School of Management

The best universities in the world are known for the quality of their research activities, the focus of their research activities, their productivity in terms of measurable output in the form of papers, patents and supporting research grants from the industry and the government. The revenue generated by the faculty and students as part of consultations helps support the ecosystem of research in improving both the facilities at the laboratories and the personality of the Research scholars – both at the postgraduate and doctoral levels. The knowledge generated by the specific research group is acknowledged by the research community if the research adds to the existing knowledge base. Sometimes, the research work is breakthrough and hence takes time to be accepted by the research community and get acknowledged.

Certain blue ocean research activities are not well understood by the industry and/or the government funding agencies, and tend to get lost somewhere.

The transition from a teaching institute to an R&D focussed institute happened in the good old past, and the R&D activities at IIT Bombay have shown light to many inventions and innovations from the incremental to the radical, helping the cause of society in its growth. By the continuous toil of the faculty members and research scholars, IITB has achieved an impeccable position in the world's research community and our scholars are well-known. All the above noted virtues of an excellent research university have been far exceeded in both numbers and quality.

The focus of IITB's research community has traditionally and very aptly been that of developmental towards the industry, the country and the ecosystem in which any research may exist. The freedom to choose one's research focus has encouraged researchers to diversify even in a single department like Metallurgy and Material Science, from cutting-edge cancer research to neutron detectors; from ULSI development to advanced Artificial Intelligent Systems in Electrical Engineering; from advancing technologies to improve the fuel efficiency of vehicles to prototyping and developing low-cost, highly usable prosthetics in Mechanical

Engineering; from Natural Language Processing to Supercomputers in Computer Science. In addition to this, Light Combat Aircrafts in Aerospace Engineering for developing India's indigenous defence capabilities, mutual fund research to developmental economics in SOM and HSS and the Rupee symbol and other innovative concepts from IDC have all contributed to our rich research and development progress.

Despite such indispensible contributions, there are issues affecting the R&D systems at IITB. One (rightly or wrongly) is the highly rigorous process of evaluating research internally, before it gets published. Second, certain blue ocean research activities are not well understood by the industry and/or the government funding agencies, and tend to get lost somewhere. Coming from highly experienced faculty, these research projects usually have the potential of changing the realms of technology.

To cure these issues, some researchers pick up courage and devote their souls to their chosen cause, and very often than not, come out with solutions to challenges plaguing the society. Their cause is supported by representatives at all levels, from students to faculty members. ■

Emotionally Literate Computers: Analysing emotions of social media users

■ **BALAMURALI A. R.** Research Scholar, Computer Science & Engineering Department

Human emotions are very instrumental in deciding the dynamics of markets and societies. Right from what needs to be bought for today's dinner to who should be in power, is decided by this powerful force. Evolution of internet technology has enabled users to post their needs, aspirations and emotions seamlessly into the web. This has created a huge amount of user-generated data loaded with information. My research is in Sentiment Analysis (SA), which deals with automatic extraction and analysis of human sentiment on the web.

For assessing the sentiment of the text, one needs to know the meaning of the text. Existing approaches do not consider the meaning of the text while analysing

Can the data from popular site – for instance, Twitter – be used for prediction tasks based on the sentiment content of the website's users?

their sentiments. They rely on sentiment-based lexicons or syntax-based features for understanding the underlying sentiments. My work focuses on incorporating the meaning of the text while analysing its sentiment.

The same word in different contexts has different meanings and hence, a different sentiment. For example, the word 'unpredictable' in the following sentence – 'the movie was so unpredictable' has a different connotation with respect to a sentence like 'the steering of the newly-launched X series is unpredictable'. In the first sentence, 'unpredictable' is used in a positive context whereas in the latter, it is a negative or undesirable trait.

Distinguishing the underlying meanings of sentences based on their context can be detected using a natural language processing task called Word Sense Disambiguation (WSD). This task crudely means analysing the text for its meaning. Our current methodology for sentiment detection relies on features generated

by automatic WSD engines, and the results obtained so far have been promising.

Another area of my research's focus is the relation between sentiment analysis and social media networking. A large majority of India's urban population now uses conversational media to post information and their emotions. Can the data from popular site – for instance, Twitter – be used for prediction tasks based on the sentiment content of the website's users?

For example, an interesting project that we are working on involves predicting the price of a particular company's share at a particular instance using data from Twitter. This project is in its nascent stages.

At present, we have developed an application in collaboration with AOL India to process micro-blog posts for sentiment detection. This system is active.[1] ■

1. http://www.clia.iitb.ac.in/cfeelit-2/

Playing Eye-Spy: Monitoring traffic with Video Sensors

■ **AJAY NANDORIYA** Final Year M. Tech., Electronic Systems

A severe consequence of insufficient infrastructure planning has been traffic congestion, which, as we all witness every day, has grown into a severe problem. Earlier, solutions to manage congestion pointed to laying down more lanes. The problem with this approach is the reality of limited land area, specially in over-crowded cities.

We believe that the emphasis should be on better information and control to use the existing infrastructure more efficiently. Having prior knowledge of traffic patterns will definitely help in planning our cities better. One way to accomplish this is by optimising the usage of available resources.

However, a better traffic surveillance system also needs better vehicle detection and tracking

techniques. Earlier, traffic planners would use magnetic loop detectors, sonar detectors and microwave detectors. But they are very expensive to install and maintain. Also, because they can't detect slow-moving vehicles, their efficiency is limited.

Video sensors offer relatively low costs of installation and also provide wide area monitoring, allowing analysis of traffic movements at road junctions. In addition, they can also do speed measurements, vehicle counts and classifications, as well as road assessment.

Computer-vision based tracking approaches for collecting data about vehicle volume is an impressive improvement over the current manual data collection methods. Manual methods are expensive due to the labour involved, and plagued by inaccuracies caused

We believe that the emphasis should be on better information and control to use the existing infrastructure more efficiently. Having prior knowledge of traffic patterns will definitely help in planning our cities better.

by fatigue. The data collected using this framework will be helpful in monitoring the road traffic in a better way. It is our belief that accurately collected information about traffic patterns in an efficient, inexpensive manner can revolutionise the planning of road networks in the future. ■

Keeping it Light: Resistance Random Access Memory (RRAM)

■ **GURUDATT J. RAO** M. Tech. Student, Department of Metallurgy & Material Science

As the world is progressing fast, so are its needs. From the prospective of microelectronics, faster computing and higher data storage are the biggest bargaining points. Higher data storage requires pushing the scalability down to the nano-scale without losing control. Scalability can be defined as the ability of a system to perform under increased load. Presently, memory devices are basically charge-based. The charge is stored in capacitor-like configuration, which is responsible for remembering states in the digital world, guided by 1 and 0.

But the ever-increasing demand for massive storage for computing in a limited space is severely stressing the relatively newer versions of memory devices and flash memories.

Similarly, our manner of progress has given rise to concerns of the environmental impact. Energy conservation – being the need of the hour – is strictly mandated in every research undertaken.

Majority of the energy drainage is owing to the loss during booting (or starting) of laptops and PCs, which may seem insignificant but harm the system to a great extent. Our team has taken up the challenge to cater to both these needs. With regards to scalability and data storage, we have decided to go in for a non-charge based concept for data storage. To achieve this, we have decided to use properties of specific materials. These materials have the special ability to be modified in the presence of an electric field and have been extensively studied for their magnetic behaviour.

The main advantage of such a memory is the simplicity of its structure, ease of controllability, repeatability, reproducibility and adaptability to the present-day digital circuitry.

Above all, the two most important features are compactness of data storage and its non-volatile nature of storage. The amount data stored in such a device at the nano-scale level can be comparable to any present flash memory device. Owing to its non-charge based concept, the scalability of our device is a non-issue.

Our project not only targets the rapidly expanding memory device market by providing alternatives and smaller memory devices, but also looks at the research which helps society in its quest for Green Technology.

Similarly, as the memory is nonvolatile in nature, it can be easily used to remember the last state in which it was programmed. This can solve the problem of non-volatility of the present-day RAMs, which require continuous power supply during startup and during processing. This will reduce substantial load on the power supply, which indirectly leads to saving of valuable power.

Our project not only targets the rapidly expanding memory device market by providing alternatives and smaller memory devices, but also looks at the research which helps society in its quest for Green Technology. ■

Growing Electricity in your Garden: Smart Grids for Indian Homes

■ **V. S. K. MURTHY BALIJEPALLI** Research Scholar, Electrical Engineering Department

Have you ever imagined answering Swami Vivekananda – 'What you did for thenation?' Given the current energy starvation, sustainable energy development is the need of this hour and the key to this question. What would it be like if you were technologically enabled to generate power in your home – even if it is a few odd kWs – and inject this supply into the grid?

Imagine a Gandhian model of habitation – electricity generation at the household level and energy self-sufficient villages. If we could do it with Khadi, then why can't we do it with power?

For all these wishful thoughts to come true, I started my research on the smart grid in early 2008. The research deals with identifying the requirements for an Indian smart grid. The technical aspects included a model to measure responses to the demand for a smart grid. Real-time pricing models for smoothening peak load curves, including price forecasting were also required.

Imagine a Gandhian model of habitation – electricity generation at the household level and energy self-sufficient villages. If we could do it with Khadi, then why can't we do it with power?
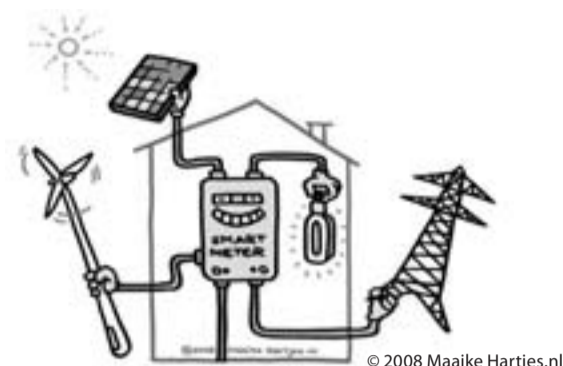
In addition to this, it was necessary to build common information models to integrate the power system applications among control centres at different levels of electrical hierarchy, with their allied communication infrastructure requirements.

Any research story wouldn't be complete without

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its corresponding applications in development. The developmental work on 'System and Method for Price Forecasting' has got good attention in the Power industry and is going to be commercialised soon. Currently, we are working on building viable and pragmatic demand response models (with RTP) for the Indian electricity market, to integrate end consumers.

The Government of India has formed an Indian Smart Grid Task Force (ISGTF) in May, 2010. It is unveiling an ambitious $132 million (₹600 crore) pilot smart grid project to demonstrate power saving measures and improve energy efficiency in distribution networks across the country. I hope to see some of my work being used in this project. ■

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Taming Wings: Vibration control of Aircraft

■ **PARMEET SINGH CHHABRA** M.Tech. Student, Aerospace Engineering Department

Active vibration control is need of the hour in all kinds of industries. The reasons for controlling these vibrations may be different in different industry sectors. While in some sectors it is required for greater performance, in some others it is used to elongate the shelf life of machineries. Consider, for example, the wing of an aircraft. When an aircraft is flying – specially at high speeds – owing to gusts of wind or sudden loading, the wings may begin vibrating. If these vibrations are large in amplitude, the wing may get damaged. Even if the amplitudes are low, the performance of the aircraft gets hampered. Because of this, an aircraft is sometimes not allowed to go beyond a certain speed. But if these vibrations could be controlled, higher speeds, if required, can be achieved without worrying much about failure or performance of the aircraft.

When an aircraft is flying – specially at high speeds – owing to gusts, or sudden loading the wings may begin vibrating.

Vibrations can be readily controlled through the use of Piezo-actuators. Piezoelectric materials deform when subjected to a potential difference. This basic property makes them very useful for vibration control applications.

Damping a structure is achieved by reducing its total energy. Energy reduction happens (in general) by applying a force at a point on the vibrating structure,

in the direction opposite to that of the velocity at that point, at that instant. This purpose is served by piezoelectric actuators fixed to the structure. It is more or less like opposing the motion at every instant, by applying a force. Velocity sensed at a point on the structure is sent to piezo-actuator via an amplifier and controller, in the form of voltage. The piezo-actuator, in turn, tries to deform the structure in the direction opposite to that of the vibration. This action provides the requisite force to dampen the vibrating structure.

The research study may be further extended to identify optimal places on the structure, where a piezo-actuator should be mounted in order to achieve maximum damping, that too in less time. Apart from this, novel ways of using it to efficiently control vibration might be analysed as well. ■

Coating the Thin Line: Neutron Detectors

■ **PRADIP CHAUDHURI** 4th Year PhD Student, Metallurgical Engineering Department

Detection of nuclear radiation from various known and unknown sources is critical for health safety. It also helps prevent illicit traffic of nuclear materials – which is imperative for national security.

Several methods have been used for the detection of thermal neutrons. However, most of them are either bulky or not very sensitive to the thermal neutrons. Neutrons are sub-atomic particles that have no charge

Neutrons are sub-atomic particles that have no charge – which makes them even more difficult to detect. We have developed a new technology to deposit a thin film of Boron Carbide (BC), which acts as a neutron absorber material.

– which makes them even more difficult to detect. Efficient thermal neutron detectors are an urgent need for our national Atomic Energy Programme. Silicon-based diodes coated with a thin film of neutron-reactive material have been shown to act as excellent neutron detectors. However, technology based on thin films will also see significant applications, including nuclear security.

Unfortunately, neutron detection is not an easy science, because a neutron has no charge. Neutrons can travel

Fig. 1. Schematic of neutron detector

Fig. 2. Interaction of neutron with ^{10}B

many centimetres through the matter without any type of interaction and thus can be totally invisible to radiation detectors. For neutron detection, we require neutron-reactive material which converts the neutrons to secondary charged particles which can then be detected. We have developed a new technology to deposit a thin film of Boron Carbide (BC), which acts as a neutron absorber material. ■
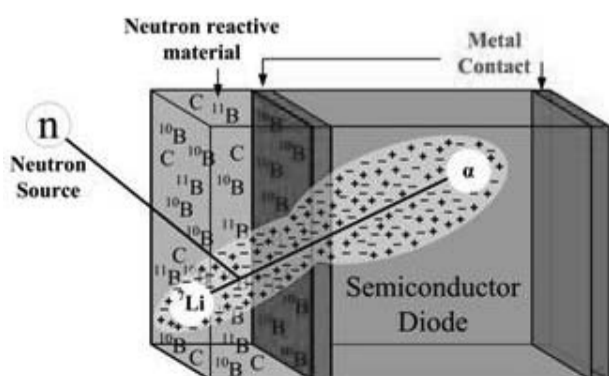
Jet-Packing the Battery: Advanced Materials for Lithium-ion Batteries

■ **PAVAN VELURI** MSc.-PhD Student, Energy Science & Engineering Department

Batteries with high energy and high-power density are in great demand for emerging electronic devices. Everybody wants their phones and IPods to last longer on a single charge. Nowadays, lithium-ion batteries have become common in consumer electronics. Each battery

Batteries with high energy and high-power density are in great demand for emerging electronic devices. Everybody wants their phones and IPods to last longer on a single charge.

has two terminals called an anode and a cathode which are together called electrodes. Since the performance of the lithium-ion batteries depends upon an electrode's electrochemical properties, improvements have to be made to meet demanding requirements.

One of the best options to meet these requirements is by using nanostructured electrode materials. Nanostructured materials provide a large surface area and need only a short path length for lithium ion transport. They can also withstand the strain produced during the lithium insertion-desertion process. In our project, we are synthesising different morphologies of iron oxide which can be utilised as a negative electrode for lithium-ion batteries. We are mainly focussed

on preparing hollow nanostructures of metal oxides. The diffusion length, i.e. the distance an ion moves before losing its charge, of lithium ions decreases to a greater extent in these materials.

Cavities in these materials may provide additional space for the storage of lithium ions, and increase their capacity. Another advantage of hollow nanostructures is that the void in these materials buffers against the local volume change during Li insertion and desertion, helping in aggregation of the electrode materials which thereby enhances cycling performance. The improvement in cycling performance implies that more charge is stored during charge-discharge cycle, and the number of cycles increases under approved usage. ■

The Portable Travel Agent: Smartphone App for Business Travellers

■ **POOJA RASTOGI** Alumnus (2009), Industrial Design Centre

Today, millions of people are travelling internationally for business. Business travel comes along with worries such as hectic schedules, unfamiliar destinations, trip expenses management, recalling meeting experiences, among others. The life of a business traveller is not as attractive as it seems to be. Smart phones, already in wide usage by business travellers, can play a big role in the kind of information management that business travel demands. In my project, I explored how a smart phone application can ease the life of a business traveller. This mobile solution is termed as 'BizBag', and is designed on Windows Phone 7 in collaboration with Microsoft, India. 'BizBag' helps frequent business travellers in gathering, organising and retrieving information specific to his or her needs, thus helping the traveller during his or her various travel phases.

In a traveller's pre-travel phase, 'Bizbag' helps the user gather important documents, itinerary and destination details such as weather, events and places to visit.

In a traveller's pre-travel phase, 'Bizbag' helps the user gather important documents, itinerary and destination details such as weather, events and places to visit. It also creates a backup of emails and documents on the mobile phone for quick viewing. 'BizBag' helps its users in preparing and sharing meeting notes and compiling travel expenses.Post travel, 'BizBag' helps its users in retrieving information gathered on the trip

in an organised manner, in the form of, say, compiled meeting notes and expense reports.

In the 'Bizbag' system, a user can utilise three important functions:

1. A user can add trips and tag important mails and documents to 'Bizbag'.

This solves some of the major problems such as the user missing important information, documents or them being saved in an incompatible format while he or she was preparing for travel. Also, GPRS charges are very high. When a user requires lots of information on a particular destination, 'Bizbag' gathers all that information before user starts his or her trip and can use them wherever required.

2. While on travel, a user can capture meeting notes and expense reports on 'Bizbag'.

This information can be retrieved later. 'Bizbag' organises, creates a version and backup of all the meeting notes, documents and even syncs them with sky drive folders wherever and whenever Wifi is available, hence providing 100% backup. The data captured is always stored and categorised with its date and venue.

3. The user can select a preferred event happening on a particular destination and move it to his or her calendar.
.
'Bizbag' scrutinises many events and celebrations happening in the city with respect to the user's schedule,

reachability and interest. 'Bizbag' showcases the relevant events to the user and he or she can select the event from the list and fix them to his or her calendar.

'Bizbag' tries to bring a user's major travel activities – whether they are official or personal – on the same track, so that he or she can carry his or her office easily while travelling, and be relaxed even after travelling. During its design phase, 'Bizbag' was prototyped on a Microsoft Expression blend. Later, it has been tested with about 10 or 12 Windows Phone users within Microsoft and with other IT companies. ■

'.. Perhaps the most effective, scalable and economic solution to all our monsoon worries!.. Hitch is, it doesn't LOOK 'World Class'!

Transcending the Classroom: New Framework for Engineering Education

■ **PRERAK MEHTA** Alumnus (2009), Industrial Design Centre

Given the current scenario of engineering education in India, there is a dire need of improvement in the way engineering education is structured, and the guidelines it follows. With information and communication technologies (ICT) having become accessible and widespread, it is bound to play a vital role in enhancing the state of engineering education.

The existing structure and framework of engineering education and its surrounding ecosystem have been studied in great depth. My research proposes a new framework for engineering education using ICT. A generic level component-breakup for engineering has been made, followed by a detailed description of each component, again on a generic level. Each detailed

> **Our entire engineering education scene needs to move towards a self-learning environment, which is totally lacking in today's faculty-dependent model.**

description has been followed by ways of executing them based on different branches of engineering.

Our entire engineering education scene needs to move towards a self-learning environment, which is totally lacking in today's faculty-dependent model. The new framework components – along with the guidelines – will pave the way for a 'self-learning environment'-based model for engineering education.

In addition, the research proposes an online directory for free web-based engineering content as a common resource platform to aggregate the scattered content on the web based on the new framework. It will be a founding stone for ICT based initiatives in engineering education in India. A basic descriptor image is shown.

My research has been selected as a full research paper for publication and presentation at International Conference on Engineering Design.[1]

The complete project report (explaining each component of the new framework in detail) for download
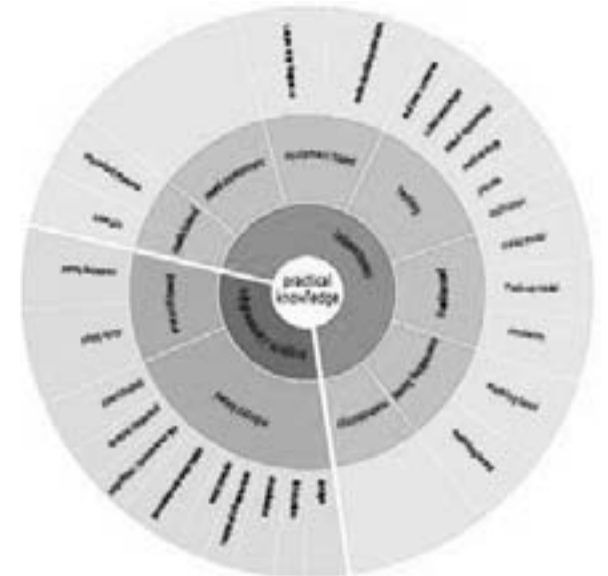
and reference as well as the prototype of the engineering directory portal is available.[2] ■

1. http://www.iced11.org/default.aspx
2. http://homepages.iitb.ac.in/~prerak/

Powering the Sun: Inverters for Solar Energy Systems

■ **SANDEEP ANAND** Research Scholar, Electrical Engineering Department

Fossil fuels are depleting, the demand for energy is increasing and the concerns over climate change because of carbon dioxide emissions remain tense. All these global issues greatly motivate the use of renewable sources of energy. Solar photovoltaic systems (PV) are mechanisms which convert the sunlight shining on a solar panel into a voltage difference, producing electricity. PV systems are a promising renewable technology for India because thanks to our sub-tropical climate, we possess high intensity solar radiations in various parts of our country.

A solar PV system comprises a PV array, electronic converters and batteries. Conventionally, alternating current – the one supplied to homes – is used to transmit and distribute the power generated by the PV system. However, a great amount of energy is lost during DC-to-AC conversion of PV energy and AC-to-DC conversion for the battery. To address this loss of energy, we have proposed a new DC distributed generation system for medium-power PV systems. This new

system offers higher efficiency than the conventional AC system, and thereby reduces the PV array units by 10 to 22%. This makes PV systems more sustainable, since investment costs are reduced significantly.

However, for large PV systems, direct feeding of power into the main AC grid without storage is advantageous. Grid feeding inverters extract the maximum power possible from a PV array and feed it into the grid. Currently, inverters have a low operational life (5-8years) as compared to PV arrays (20-25 years). After four or five years of installation, PV systems frequently get shut down because of the failure of their inverters. Owners lose a large amount of revenue because of the downtime required for replacing these inverters.

Our research team at IIT Bombay has identified the reasons for the low operational life of inverters, and we've proposed a new circuit topology to overcome them. The major advantages of our proposed solar inverter circuit are: high reliability and low cost. Another

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very exciting part of our project is the 5kW grid-feeding inverter that we are constructing right now. This inverter will improve the longevity of other inverters, and reduce the costs of changing faulty inverters in functional PV arrays. This also reduces costs of ownership, thereby making solar power generation a financially viable enterprise. Suitable for our country's climate, this grid is our way of supporting the in-house development of solar inverter technology in India. ■

SHORT FEATURE | Towards Academic Social Responsibility

■ **SHAMLAN M. S. RESHAMWALA** PhD Student, Biosciences & Bioengineering Department

Corporate Social Responsibility, or CSR for short, seeks to promote the interests of the society that a corporate entity interacts with. Companies strive to showcase their public interest initiatives to drive home the point that they share responsibilities that go beyond the bottom line.

However, are not academic entities expected to be proactive in displaying their concern for the needs of the public? This is especially true for universities and institutes that are engaged in research. Instead of resurrecting the age-old (and sterile) debate of 'basic versus applied' research, what we as academic researchers ought to strive for is to make our research more relevant to the society of which we are an integral part.

Who decides whether our work is relevant? It is proposed that it is society that must do so, as it is public support and approval that will give our endeavours their legitimacy.

A clarification is in order – we need not appeal to the lowest common denominator to decide our TRP. Rather,

> **Instead of resurrecting the age-old (and sterile) debate of 'basic versus applied' research, what we as academic researchers ought to strive for is to make our research more relevant to the society of which we are an integral part.**

it is the opinion of the common man, who is moderately educated and can follow a logical argument, who should be our concern.

How is this to be achieved? One of the simplest ways is by effectively communicating our research in a manner and language that the aforementioned common man understands. IIT Bombay has already taken a step in this direction in the form of 'Researchoscope', which is a series of freely available videos of PhD students talking about

their research. Though this is a positive beginning, the impact of this initiative is restricted to those who have access to the internet and can understand English.

A better way to communicate our research is by publishing a short summary of the work in a vernacular language. This can be implemented by asking PhD (and even Master's) students to prepare a short document (not exceeding five pages) in a language that they are conversant with, that highlights the approach they took in solving a particular problem. The document should be non-technical, and must contain adequate background information for a common man to understand the broad contours of the field. The main results should then follow the explanation.

These documents can also be made available on the Central Library's website for free downloading. Feedback from readers should be solicited and encouraged.The greatest benefit of this exercise would be that it would force us to think about the common man who will read, and ultimately judge, our work. ■

Unearthing Mysteries: Geology Department's Field Trip

■ **CHHABI JAIN** 1st Year M.Sc., Applied Geophysics Department with inputs from **PROF. CHRISTOPHER J. TALBOT** Uppsala University, USA

The geological fieldwork at Ambaji in Gujarat is an annual tradition of our department. It is a part of the curriculum for 1st year Geology students, providing them with hands-on experiences of geology. It enhances our understanding of the subject, as we actually study the rocks, their constituent minerals and structures we read about in books.

This year, the field trip to Ambaji was undertaken by 14 1st year students of Geophysics, 30 1st year students of Geology and five PhD and M.Tech. students of our department in December, 2010. We were guided by professors Tapas Kumar Biswal and Soumyajit Mukherjee. Four cooks from IITB including Mr. Stephen constituted our support team. Prof. Biswal has been studying this terrain for two decades or so. This was the twelfth batch of IITB students he was instructing in the field. Prof. Mukherjee, on the other hand, is relatively a new entrant in this area as this was only his second visit.

In the evening, Prof. Mukherjee made an unusual start to fieldwork at a nearby outcrop of granite gneiss where he showed us weak foliations and conjugate fractures. Our field work was not restricted to Ambaji alone, but included many other places around it. Each day we had to submit a resume of our field study to Prof. Mukherjee.

The first basic things which we were taught in the field were measuring attitudes of planes and lines using clinometers and locating ourselves on the map. We measured the fracture planes in the granite gneiss, Prof. Mukherjee's first outcrop, and got them verified by the teachers.

The next area of focus was mineral identification and petrology. Ambaji and its surrounding towns were built on the Aravallis, one of the oldest mountain ranges of India. Rich with its prolific tectonic history, both igneous and sedimentary rocks of the

area enjoyed low-grade metamorphism. I was more interested in an outcrop of mica schist which had a high percentage of quartz. Shining muscovite could be easily recognised there.

A number of caverns and crevices could be found in the granitic hills, many hidden behind thorny bushes, desert shrubs and cacti. When we first examined these rocks, an instant competition started to see who could collect the best sample to take back to IITB. While boys could be seen trying to climb up to reach undisturbed samples, girls were seen breaking rocks to extract an appropriate specimen. We had hung our hand lenses round our neck for convenience and studied every rock till we spotted the finest one.

> **Even in a fortnight, the field trip taught us more than what we could ever learn from books. Besides geology, it taught us how to work as a team, adjust in a group and to find how to make the best out of even the worst situations.**

Apart from mineral mining and other geologically significant structures, Ambaji is well-known for its marbles. While the Makrana is India's best quality marble, Ambaji marble is not far behind. On the last day of our trip, Prof. Biswal took us to visit a marble quarry. An entire mountainside seemed to have been excavated. At its base, gigantic slabs of marble were being cut, washed, polished and segregated from the unusable rock. The marble glistened pearly white and grey-green impurity minerals made natural patterns on the stone. Marble deposits are fast depleting in the world. The quarry we visited was estimated to be

Students on department field trip

productive for another 50 years only.

Towards the end of the field trip, students were divided into four groups. Each group was assigned a particular region on the topo-sheet to map. Everything that we had learned so far in the field was put to a test. For three days, each group travelled to its assigned destination. In the process, two groups even encountered some hostile villagers who refused to allow the students to proceed further and even threatened to behead them on grounds of trespassing. Despite these minor impediments, the group work was fun. We studied rocks on our own.

Even in a fortnight, the field trip taught us more than what we could ever learn from books. Besides Geology, it taught us how to work as a team, adjust in a group and to find how to make the best out of even the worst situations. Our analytical skills and observational powers were greatly enhanced. The difficult terrains we climbed, the knowledge we gained and the friends we made were our precious non-geological benefits. ■

Blossoms Under the Banyan Tree

■ **ISHA RAVI** Class 12, Campus Kid

IIT Bombay is one of the premier institutes in the world, renowned not only for its teaching but also for its world-class research and research facilities.

How does being situated in such a great place to learn affect our local school, Kendriya Vidyalaya, IIT Powai?

Our school has always prided itself on being ahead of the others, be it in academics, science competitions, the arts or sports. Is this a direct result of being in a place that offers so much opportunity to develop all kinds of skills?

Since the first standard, we in school have been using the campus facilities freely; performing Independence and Republic Days in the Gymkhana grounds; having little picnics by the nursery or the lake; practising for the interschool, regional and national level sports meets in the SAC, badminton courts and the swimming pool; and last year, performing our Annual Day to a crowded SAC auditorium.

More recently, IITB and the school have started working even more closely together – school students are now permitted access to some technical events and exhibitions including high-profile lectures in Techfest, Mood Indigo, Zephyr and others. Parent professors often visit the school to talk about their fields in the

Illustration by Ankita Roy, IDC

morning assembly or as part of clubs like the Robotics, Animation or Maths club.

Needless to say, all these developments have greatly increased student interest and participation in science events and competitions, as well as co-curricular activities. In addition, we have opportunities that most other Government schools don't have – like getting to attend eco-Ganesh workshops and walk over to IDC to admire cutting-edge design displays.

But are we really utilising the benefits of being in a rich learning environment as well as we should? IIT is well known for its progressive R&D. But school students in general are unaware of the potential of the laboratories and research facilities on the campus. Even the handful of pupils whose family members are involved in research don't ask too much about exploring the boundaries, visiting the laboratories and learning

> **In fact, one would expect that attending school in such a temple of learning would itself cultivate an automatic interest and curiosity in science and technology, leading to, say, more innovative science projects.**

more about the latest scientific developments.

In fact, one would expect that attending school in such a temple of learning would itself cultivate an automatic interest and curiosity in science and technology, leading to, say, more innovative science projects. Sadly, this is not the case. It might even be the other way round; that we take the campus

environment for granted, not realising its value before it is lost.

This being the situation, shouldn't we do something to remedy it?

If the proper interest is expressed, it might be possible for IIT students (if they have the time and inclination) to have interactive sessions in school with us students about their R&D work in a fun way. Interacting in such a manner would probably make students more willing and eager to ask questions and find answers. School students could visit some of the IIT laboratories by appointment and talk to the researchers about their work. Getting to see things is a key factor in cultivating a deep-rooted interest in young minds, to make them want to learn. If the seed of desire, to learn and then create is implanted early, it will pay rich dividends not just for the individuals, but eventually, for the entire nation. ∎

R&D FEATURE

Spoken Tutorial: A Collaborative and Scalable Education Technology

∎ **PROF. KANNAN M. MOUDGALYA** Chemical Engineering Department

A spoken tutorial is an audio-video tutorial that explains an activity performed on the computer. An expert explains the working of a software by demonstrating it on the screen, along with a running commentary. A screencast software makes a movie of the entire activity, both the screen and the spoken part. This movie is the spoken tutorial. It is ten minutes long. One can reproduce the commands shown in the tutorials side-by-side and thus use it as an effective instructional material.

We have been using this methodology to create a series of tutorials in open source software families, such as L TEX, Scilab, GNU/Linux, ORCA and Python. We have selected the duration of a typical spoken tutorial to be about ten minutes long. Although only a small topic can be covered in ten minutes, by stringing them together, one can come up with study plans that are capable of teaching advanced topics as well.

Our approach involves the creation of a script before creating the video, just as a movie is based on a script. It is possible to translate the script into other languages and use it to change the audio part only – screen shots continue to be in English. The effort required to change the audio is only about 5% of creating the original. [1]

This method has the potential to reach out to people weak in English, while not compromising on employability. Spoken tutorials can also be used to bridge the digital divide: buying train tickets online, locating low-cost agricultural loans and locating information on first-aid and primary health care. The target audience for a spoken tutorial is a remote child, working alone at midnight without anyone to help her.

We are working on the task of creating a large number of spoken tutorials, through collaboration. Ensuring quality when the creators could be disparate people, such as students, housewives and unemployed, seems to be a good R&D problem to address in the area of education technology. This is a problem our group has been working on for the past three years.

I will now highlight the collaborative nature in the creation and use of spoken tutorials. Let me begin with the creation. The sequencing of the tutorials and their

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content is to be decided by an expert. The script for an individual tutorial can be written by a person who knows that activity well – she need not be an expert in the entire software. A novice check of the script is an important requirement of our process. This makes even the beginners feel wanted and actively helped by the experts. A novice who has validated a script can create the tutorial through screencast, and also get paid for it. Our project must be one of the few that pays a person to learn.

Translation is typically done by mature and hence elderly people. The people who give their voice and do the dubbing turn out to be youngsters, who are comfortable with the required technologies. This approach allows difficult technologies also be made available to languages with low population, such as Sanskrit and Boro. One need not have experts in the domain. What is required is for one to translate the spoken part.

The target audience for a spoken tutorial is a remote child, working alone at midnight without anyone to help her.

We received permission from the PHP academy to dub and use their PHP/MySQL video tutorials. Many programmers from rural areas found the accent difficult to understand. In contrast, school-going children at IIT Bombay found the accent easy to follow. They transcribed it and also lent their voice to dub into Indian English. This shows the effectiveness of collaboration – contribution by a few people, even children, can help the entire society.

As the spoken tutorials are created for self-learning, the domain expert need not be present to conduct the workshop. The organiser of the workshop only needs to know 'how to use' this material. As a result, anyone can conduct these workshops. We have validated this approach through student club-organised Linux workshops in a college in Alwar, Rajasthan and SASTRA university in Thanjavur. We provided the instructional material through a CD and moral support through Skype. We also conducted online exams, before and after the workshops and gave certificates. The Alwar students showed an 85% improvement after the workshop. Moreover, all of them passed the second test. Using ORCA spoken tutorials, our staff member Krishnakant Mane successfully conducted workshops for visually impaired children at IGNOU, Delhi from Andhra Pradesh.

For the last three weeks, we have conducted spoken tutorial-based workshops at IITB. We ran the L TEX workshops every day, from 6 pm for two hours. More

> **Spoken tutorials are created for self-learning – the domain expert need not be present to conduct the workshop.**

than 200 students participated in these workshops, half of them being PhD students. We have now started Linux workshops. Once again, there has been an enthusiastic response from the campus community.

We have completed about 400 tutorials. We are now trying to get partners who will share our enthusiasm to create the content and to organise workshops. We are now working with a start-up at IIT Madras and an NGO in Bengaluru. We hope to generate at least 600 more tutorials and conduct 100 spoken tutorial based workshops by 31 March, 2012, the last date for funding by MHRD. But there are indications that this project will continue, as the National Mission on Education through ICT that is funding this project is likely to continue in the next plan period as well.

This has been an exciting project with something new to learn every day. We invite all readers to participate in this excitement by collaborating with us. We also need state-of-the-art technologies. A summary of this project is available on our website.[2] ∎

1. http://spoken-tutorial.org/Xfig_Spoken_Tutorials
2. http://spoken-tutorial.org/What_is_a_Spoken_Tutorial
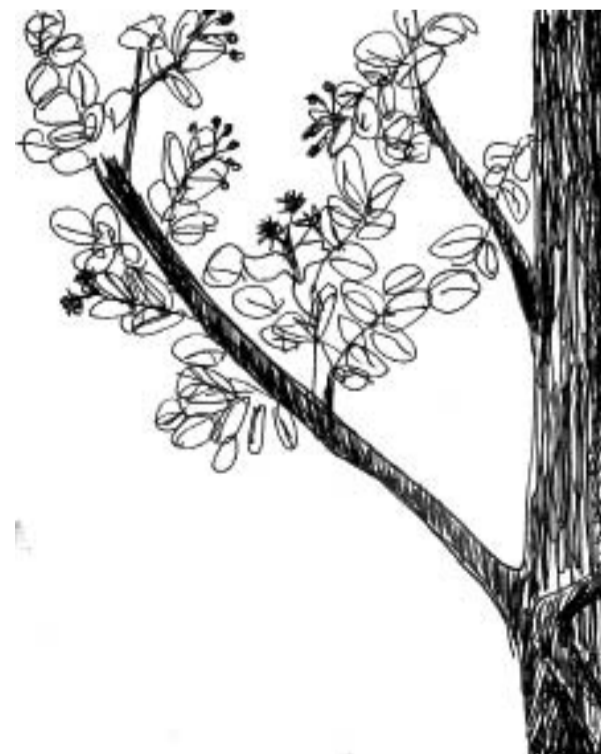
Blazing the Trail: Knowledge Creation and Research

■ **PROF. R. B. SUNOJ** Chemistry Department

I herein plan to put forward a few pertinent views underscoring the significance of undergraduate research in an institution like IIT Bombay. Beware, this article has a statutory warning that it is meant for girls and boys who are below the age of 20. If you are, proceed!

In my opinion, research is not only about realising whether one has the potential and aptitude for it. How do you know that you possess the basic ingredients to be a researcher? Well, the only way is to get into it as early as possible in a congenial environment such as what we have here in IITB. We are blessed to be living in a campus which possesses a variety of flora and fauna. There are guys here who work passionately for something that they perceive as research while others go after 'grades' in academics and 'colours' in the hostel. Depending on how naughty you are, you may choose to interpret the latter half of the last sentence in your own way. What I meant was to get listed in the hall of fame in hostel notice boards.

Research is not all about solving complicated math equations, but about nurturing a hobby in you.

Let me talk about those passionates (others are passionate as well, not just the folks being referred to here) who spend lots of their time in laboratories. I have seen many of the undergraduates work tirelessly in research laboratories. These are the ones who started realising that there is something that makes them feel attracted toward working on some cool stuff. Research is not all about solving complicated math equations, but about nurturing a hobby in you. It is about thinking and working on a 'project' in a way as no one thought before. It is about finding similarities between very different things and also to find differences between very similar things. This seems like reading a brain-teaser book.

I am sure most of you relish the happiness that accompanies cracking several tough JEE questions. Some found themselves happier just to realise that it was only (s)he who could get that right in part-B, section-II of whatever subject. Feeling unique, and to be exclusive, in matters of scholarly achievements is really wonderful. This is an inherent human desire and there are tremendous similar opportunities to fulfill in research.

Let me cite a wild parallelism from the area of glamour and fashion. When one walks the red carpet, be it in Festival de Cannes or in the Kodak theatre in Hollywood, they gleefully wear a designer outfit, which occasionally appears nutty to people at large (don't forget those fancy haircuts and tattoos). The feeling of being unique and perhaps succeeding in capturing the attention of many was indeed one of the very objectives of their acts.

Now, think of a situation wherein you found something interesting, which no one has ever found before. There is a considerable uniqueness that comes along with it. Soon enough you realise that there are forums to express that it was you (rather diplomatically, 'we', as supervisors do claim a share of credit!) who thought about it first. These are opportunities for gaining international acceptance of your original work, which you might have started a year or two before on a boring Friday night!

Preparedness is very important, as you never know when you come across a wonderful idea. Research would have to evolve over a period of time and hence I tend

[My undergraduate coworkers] believe that being part of a research group generally helps them learn many of their courses better.
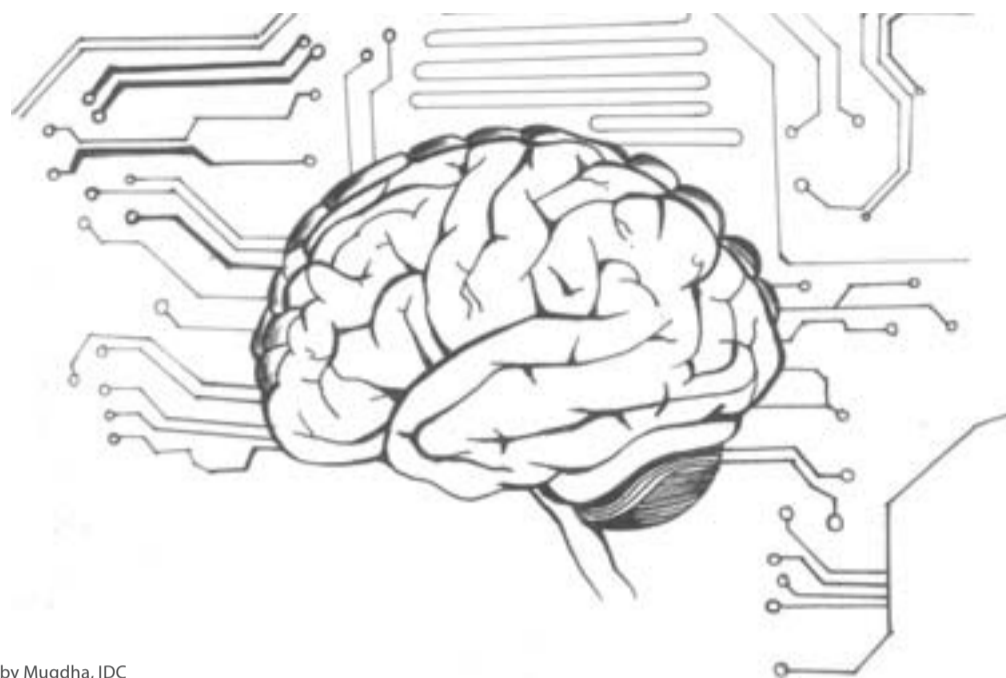

Illustration by Mugdha, IDC

to believe that set goals and target-oriented ways of pursuing research might not succeed well enough. At the same time, offshoots of a main goal might emerge to be more exciting as well as satisfying. Again, how do you go through such unchartered territories and be the first in the world to come up with such an idea, illustration, model and so on? Isn't it too much to be first one in the world for an 18 year old? In fact, it is quite doable. Just get on board, guys and see it for yourself. There is not much fun in walking through the good old paths people have been on before. Developing a desire to do something really different would be a good beginning.

With regards to the question of whether it is too early as a fresher or sophomore to get into research, my response is that there is no ideal time for beginning a research project. A new-comer will go through a steep learning curve and will find him/herself in some reasonably comforting plateau as days go by. Be patient as a beginner, and expect not to do rocket science from the first month into research. One can easily compare the situation with a one-dayer and a test match. A test match is played session by session, patiently for long to yield results. Some of the classic tests on the batsman's concentration levels are best done in a test match.

Take your time to identify whether you are enjoying what you are doing, as that holds the key. When you chew on a bite of *amla,* (gooseberry) it is not going to be sweet to begin with.

However, the more you chew on it, your taste-buds will slowly recognise that there is something in it. Now, take a sip of water just to realise how sweet the original bite turned out to be. Research would literally offer you this very *amla* feeling several times. Again, I iterate that unless you chew it, you are not going to enjoy yourself.

The only way to get to know what your potential is toward research is to just come on board. Come on in, junta! A far-fetched dream that I cherish is that if 30% of our B.Tech./Dual Degree/Int. M.Sc. students turn into doing serious research during their undergraduate stay on campus, IITB will become one of the best centres for research in science and technology and will be comparable to some of the best in the world.

Now, I'll share a few thoughts on some of the directly perceivable advantages in getting exposed to research early on. Let me simply describe some feelings shared by my own undergraduate coworkers. They believe, which I indeed endorse, that being part of a research group generally helps them learn many of their courses better. Learning more in courses synergistically helps in research as well. This is a win-win situation for these little researchers.

A related skill that one would develop is being able to bank on the vast ocean of literature for problems that come across as part of a course work or as part of a research project. I said in the early part of this note, that research

If you miss out being a researcher at some point of time here at IITB, you miss out on a lot of things – both in the short and long run of your lives.

methodology is useful in many respects. Being able to ask questions and search for a potential answers by yourself directly from the original literature is a training worth going through. (Just to clarify, 'original literature' predominantly refers to journal articles.)

Journals in most areas and conference proceedings in some areas of research are lifelines of research activities. Reading a journal article initially appears to be a difficult task, but be assured that it will become progressively easier as you go along. This puts you in a very advantageous position of being able to question several observations and interpretations that you would come across as a researcher and a student.

The best part is that the level to which you can elevate your thinking is unbelievably high. Folks, if you miss out being a researcher at some point of time here at IITB, you miss out on a lot of things – both in the short and long run of your lives. The ability to think deeply and rationally comes along naturally as you get more involved in research projects.

While crediting a course, particularly when the grading is done on a relative fashion, scores above 90% should beyond doubt be regarded as a very good performance. When it comes to research, 100% is what one aims for. The idea of partially correct results is nearly nonexistent. One should therefore thrive to achieve perfection in most endeavours relating to research. This is a hard task, given the several intertwined factors ranging from facilities to ambient humidity in the region.

In the emerging era of knowledge economy, one of the most valuable assets one can possess is certainly knowledge. Creation of knowledge of varying kinds can therefore be regarded as the need of the hour. It is to be rightly trusted that the founders of IITB have aptly imprinted the motto 'Knowledge is Supreme'. Together, let us try our level best to uphold this.

Before closing, I want to bring forth the opportunities open to you. There are several short research projects that you could be part of. You could browse through the department home pages to find out what might interest you. Contact the faculty members to learn more about on-going research and explore how you could contribute to it. The institute's initiative – 'Enthuse' – is one such activity wherein students are encouraged to get on board with the research activities in the institute. Let me log off with the hope that a few of you will begin to think of giving it a try. Won't you? ■

Building the Brand Value of Research

■ **ANTARIKSH BOTHALE** Final Year Dual Degree Student, Mechanical Engineering Department

The theme of this *Raintree* issue is Research. This is also probably a word that comes to your mind when you talk about an institution like IIT Bombay and its impressive array of faculty, students, and to some extent, facilities. A common question then is — why don't undergraduates engage in as much research work as faculty might expect or hope? Well, there is a simple answer to that. Research was never supposed to be an integral part of UG life. This is probably why the institute has Undergraduate Research Awards (URA), given to those UG students who satisfactorily complete four to six months of research activity — there aren't similar awards for M.Techs or PhDs, because they have to do research. However, apart from the fact that research is not a part of the UG curriculum, we have to see it as just one of the umpteen things that a student at IIT can do.

From what I have observed in the four years that I have spent here, IITB offers to its students a relatively neutral setting with respect to career or hobby choices. Freshers here can see all kinds of role models, and decide what kind of a life they want for themselves. I saw people doing foreign internships, performing in music bands, winning golds in Inter IIT Sports Championships, publishing papers in their third year and a few who did all of the above while being nine pointers. I saw people canning 30 lakh per annum jobs and also saw those who ditched such jobs to work in NGOs for peanuts.

To cut a long story short, I got a pretty balanced view of the kinds of things I could do while in IIT and the stuff I could pursue after graduating. Of course, that meant that I didn't see all my seniors pursuing, say research — that would be a very monochromatic view to have — but I did know enough who won URAs.

A lot of what we get into depends on what is considered 'cool' in a peer group. It is tempting to imagine that we won't be affected by such biases, but we sure as hell are. When you are at school, you see teachers praising

that wretched guy who always came first in class, and although you resented it, you wished deep down that you could also get a good rank and everyone's appreciation. Once you reach IIT, the definition of a cool student changes, and very rightly so. We want a role model who has more to him or her than just a high CPI.

Faculty members may resent this fact, arguing that anything extra-curricular should be, well, extra, and should not be given precedence over core academics. While they might very well be right in some way, I'm afraid it doesn't change a thing as far as student perception goes. While a person who has thoroughly ignored academics may be looked down upon, we would readily trade a few grade-points in favour of a more diverse profile.

Students would be more inclined towards research if they find it accessible and cool. Courses could end with a discussion of 'what lies ahead '— areas in which active research is going on, served in a palatable and delectable form.

There are other reasons too. Most students who join IIT do so with only a vague idea of what they want to do. That might be because a lot of us join IIT to secure a great life after leaving IIT. What we would do in the four years here remains unplanned and unthought of. A few students realise they have little interest in engineering and want to spend their time here doing the sort of things that would probably help them get the jobs they want. UG education introduces them to only the core fields in their discipline, and by the time third year comes, they are already lost to other avenues, where rewards seem more immediate and fulfilling.

If you have reached so far, and if you are a UG, please feel free to choose what you want to do. Research can

Research can be a lot of fun too — for once, you get to apply what you learn in courses; you can get your hands dirty and create something rather than just reading or writing about it.

be a lot of fun too — for once, you get to apply what you learn in courses; you can get your hands dirty and create something rather than just reading or writing about it. You will also realise how exams are so different from real-world problems.

A common misconception, however, is that you engage in research if and only if you want to pursue higher education (or, in IIT lingo, you want to 'app'). This is not true. You are smart, and you are at a place that has good research facilities. If you enjoy it, you might as well give it a shot while you are here. It can be a one-semester-stand, and doesn't have to evolve into a life-long relationship. But, when you are involved in a project, do it sincerely. Committing to something and then ditching it for what you consider greener pastures is just plain unprofessional. You are wasting your professor's time, and you are leaving a bad taste in their mouth, thereby ruining the prospects of students who might want to take projects under them in the future.

On the other hand, if you are a professor or policymaker at IITB, please don't get knee-jerk ideas about banning all kinds of activities here, hoping it would promote research. Also, please don't take it for granted that UGs should pursue research. Students would be more inclined towards research if they find it accessible and cool. Having to read research papers and attend PhD defences is not a cool way to be introduced to a topic. Looking at a new problem and approaching it from a newbie's perspective, unclouded by biases caused due to formal education is cool and can often be very helpful. Courses could end with a discussion of 'what lies ahead '— areas in which active research is going on, served in a palatable and delectable form.

I, personally, like the status quo! And I would not like to swap it for a situation where we become paper-churning automatons. There are other ways to promote research, of course. With 'Enthuse', the institute has tried to encourage freshmen to take up research — and by doing that, has put research in the free market economy of extra-curricular activities, the proverbial super-market shelf that a fresher here would have a look at when deciding what suits them best.

There is stuff like URAs and the prospect of foreign internships – the so-called promotional offers that might make a UG student pick up this product over something else. I like walking down the aisles, browsing the stuff on display. I like my choices. And a monopoly never did any good in the market. ■

Illustration by Akvil Sakhare, Fourth Year Mechanical Engineering

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49th Convocation Ceremony

IIT Bombay held its 49th Convocation in two sessions. Dr. M. S. Valiathan, National Research Professor, Manipal University, was the Chief Guest for Session I, held on August 5, 2011, and delivered the Convocation Address. In this session, the institute awarded PhD and Master's degrees.

In this Convocation, a total of 1,846 degrees were awarded, which also includes 226 five-year B. Tech.-M. Tech. Dual degrees. Of these, 173 are PhD, (which includes one M.Sc.-PhD Dual degree) one M. S. (by research), 12 M.Phil., 770 M. Tech., 97 M. Mgt., 57 M.Des., five PGDIIT, 18 five-year Integrated M. Sc., 158 two-year M. Sc. and 328 B.Techs. A total of 53 medals including the President of India Medal to Nisarg Kirti Kumar Shah (B.Tech, Computer Science & Engineering) and Institute Gold Medal to Manas Nitin Rachh (Dual Degree, Aerospace Engineering) were also given away at the Convocation Ceremony.

In his report, Prof. Devang Khakhar, Director, IIT Bombay, said, "IIT Bombay continues to be the most sought-after destination for undergraduate and postgraduate studies and attracts the top performers in national examinations. The master's and PhD programmes in all departments are highly selective. The number of PhD students enrolled in various programmes increased significantly in the past few years. From 771 PhD students on roll in 2001–02, this year the number has risen to 1879, an increase of over 150% in a span of just nine years."

Commenting on the occasion, Prof. Shiva Prasad, Dean of Academic Affairs said, "In the recent past, IIT Bombay had initiated many academic activities to develop and sustain research interests among students. It also started different types of dual degrees programmes, making it administratively simpler for postgraduate students to obtain a PhD degree. This includes M.Sc. / PhD dual degree in Science subjects and M.Tech./PhD in engineering subjects. We are certain that these dual degrees will help many young

students pursue their career in research with ease and provide a seamless transition to a PhD programme."

Mr. K.V. Kamath, non-Executive Chairman, Board of Directors, ICICI Bank Limited, was the Chief Guest for Session II of the convocation held on August 7, 2011, and delivered the Convocation Address. In this session, B.Tech., B.Tech.-M.Tech. (Dual degree), and M.Sc. degrees were awarded.

Prof. Devang Khakhar said, "This year, 70 of the top 100 rankers in JEE 2011 have joined IIT Bombay and this includes eight of the top ten JEE rank holders. The new undergraduate curriculum for engineering and science education has a flexibility which gives students a range of options which include a Minor in a different subject or taking advanced level courses in the same discipline, leading to a B.Tech. with Honours. As many as 147 students have earned a minor or a major or both from the graduating batch of 328 students." ■

Gay @ IITB: Out and About

■ **HARISHCHANDRA RAMADAS** Alumnus, B.Tech. (2011)

Hi! My name is Harish, and I am gay. I have graduated this year with a B.Tech. in Engineering Physics from IIT Bombay. In a nutshell, this is my story as a gay student at IITB.

The Pre-JEE Days
For most gay people, coming to terms with the fact that you are gay itself is a painful, long drawn-out procedure – I fully accepted myself for who I was only at the ripe age of 16. Being gay and closeted is an enormous burden, and can be a massive pain in the arse. It was like perpetually wearing a cloak of deceit; like my life was one huge lie.

Doing my 11th and 12th class at St. Xavier's College, one of Mumbai's most liberal institutions, hiding my sexuality was no trivial matter, and put me under tremendous pressure in nearly all social interactions with my peers. *Oh yes, she's so hot,* I'd often find myself saying that just to make sure my terrible secret remained a secret. Pretending to be someone you are not as a full-time occupation was such a bloody nuisance, it sapped me of energy, and made sure a significant fraction of my social interactions were entirely superficial.

I felt like a piece of shit every time I lied; nonetheless, lying was such an integral part of my life, such an essential protection mechanism that I forgave myself unflinchingly every time. My adolescence was no fun: a period of confusion, lies and deceit. Lying to my best friends – and lying to them so often – made me miserable.

Frustrated Fresher
Entering IIT as a fresher in 2007, I swore off the lies. *Never again shall I pretend to find a girl attractive*, I promised myself, and this is something I have stuck to till date. But then another problem presented itself – I was certain that by the end of four years at IITB my secret would come out at some time or the other, and the possible reactions I might face filled me with dread and horror. I imagined former friends saying – *You*

bastard! All these years you've been staring at us, thinking your unspeakably filthy gay thoughts!

And so I chose the path of aloofness. Under pretence of being a muggu and having no desire for human company, I sought refuge in the institute library all through my fresher year, scrupulously avoiding nearly all social contact. I wanted to get a good CPI, flee this god-forsaken country (as I then considered it), and begin life afresh in the sanctuary of some liberal, tolerant western nation. Thankfully, I was not entirely successful in this rather pointless endeavour. For instance, my love for the Literary Arts often drew me to participating in its events.

> **Pretending to be someone you are not as a full-time occupation was such a bloody nuisance, it sapped me of energy, and made sure a significant fraction of my social interactions were entirely superficial.**

Coming Out to Friends
But I couldn't bear to keep this huge secret bottled up inside me indefinitely. In the summer vacations following my fresher year, acting on an impulse, I revealed the truth to a recently-made friend from the institute. This act, my first "coming out", as it is called, was tremendously liberating and I felt fantastically good. For the first time ever, I had a friend with whom there were no secrets to be kept: I could finally be myself! The following years, my sophomore and third year, saw me gradually come out to most of my closest friends, one by one. Each time it felt like a dream, each time I felt profoundly ecstatic.

> **My objective was to get people to at least talk about homosexuality. The first step towards understanding and acceptance is breaking the veil of silence.**

My second and third years at IITB were happy ones, with my wonderful friends, a new-found passion for Physics and Maths, and a variety of extra-curricular activities. I even had my first crush – that's right, on a guy. Being gay was no longer a handicap, social or otherwise, and I no longer felt the urge to periodically wallow in self-pity: I was content, happy and perhaps even proud of my gay-ness.

The Wild Life
Yet I was discontent – although my friends were all wonderful and sympathetic, I craved the company of other people 'like me'. During the summer after my third year, while doing my internship in the open, liberal German city of Munich, I made my first forays into the gay world, exploring several establishments in the city's Gay District. I also mustered the courage to begin posting on the Gay Bombay mailing list (without an alias!), and got to know several wonderful, interesting people in the process.

On return to Mumbai, at the start of the seventh semester, my reckless, adventurous side got the better of me and I signed up for Gay Bombay's monsoon picnic in the Igatpuri Ghats, along with 49 other gay guys. Admittedly, I returned somewhat scandalised: despite my very liberal upbringing, the culture shock was a little too much for me to digest. Nonetheless, a week later I found myself at a party exclusively for gay men – it was one wild, crazy dance floor! I also discovered the potential of the internet as a tool to connect with other gay people, and made several gay friends, both in and out of IITB.

The Wannabe Activist
All this while, I continued the process of gradually coming out to more and more friends. Every single one of them was cool with my being gay: I'd had a 100% success rate! After a certain point, I figured there was no point being so secretive any longer. I had the support of 20 of my best friends and felt loved and secure. Eventually, in my final semester, I decided to abandon all guard, and truly 'be myself', for at least one out of eight semesters spent at my dear institute. I became recklessly public about my homosexuality – from admitting that I am "interested in men" on Facebook, to putting up a large rainbow flag in my hostel room.

Frustrated at the ignorance and silence on the issue, I took upon myself to educate fellow IITians about homosexuality and how completely normal it is. I freely posted links to articles on the subject on Google Buzz and on my Gmail chat status, scandalising god knows how many people in the process. Getting up at five am on Day One of Techfest, I went on a round of the institute on my bicycle putting up Gay Pride posters (Born Gay, Follow the Ray. Born Straight, Refuse to Hate!). Sadly, the message didn't seem to get through to everybody – most posters were torn down within a couple of days. I bought a couple of Gay Pride t-shirts from Azaad Bazaar, India's only LGBT (Lesbian Gay Bisexual Transgender) store, and nervously wore them around campus, even to lectures, much to the amusement of at least one professor.

My objective all this while was to get people to at least talk about homosexuality. The first step towards understanding and acceptance is breaking the veil of silence. A few friends accused me of being overtly loud, and too reckless both for my, as well as the community's good. The best retort would have been to quote Arundhati Roy, when, in response to similar allegations, once declared, "I AM hysterical. I'm screaming from the bloody rooftops. And you and your smug little club are going 'Shhhh… you'll wake the neighbours!' I want to wake the neighbours, that's my whole point. I want everybody to open their eyes."
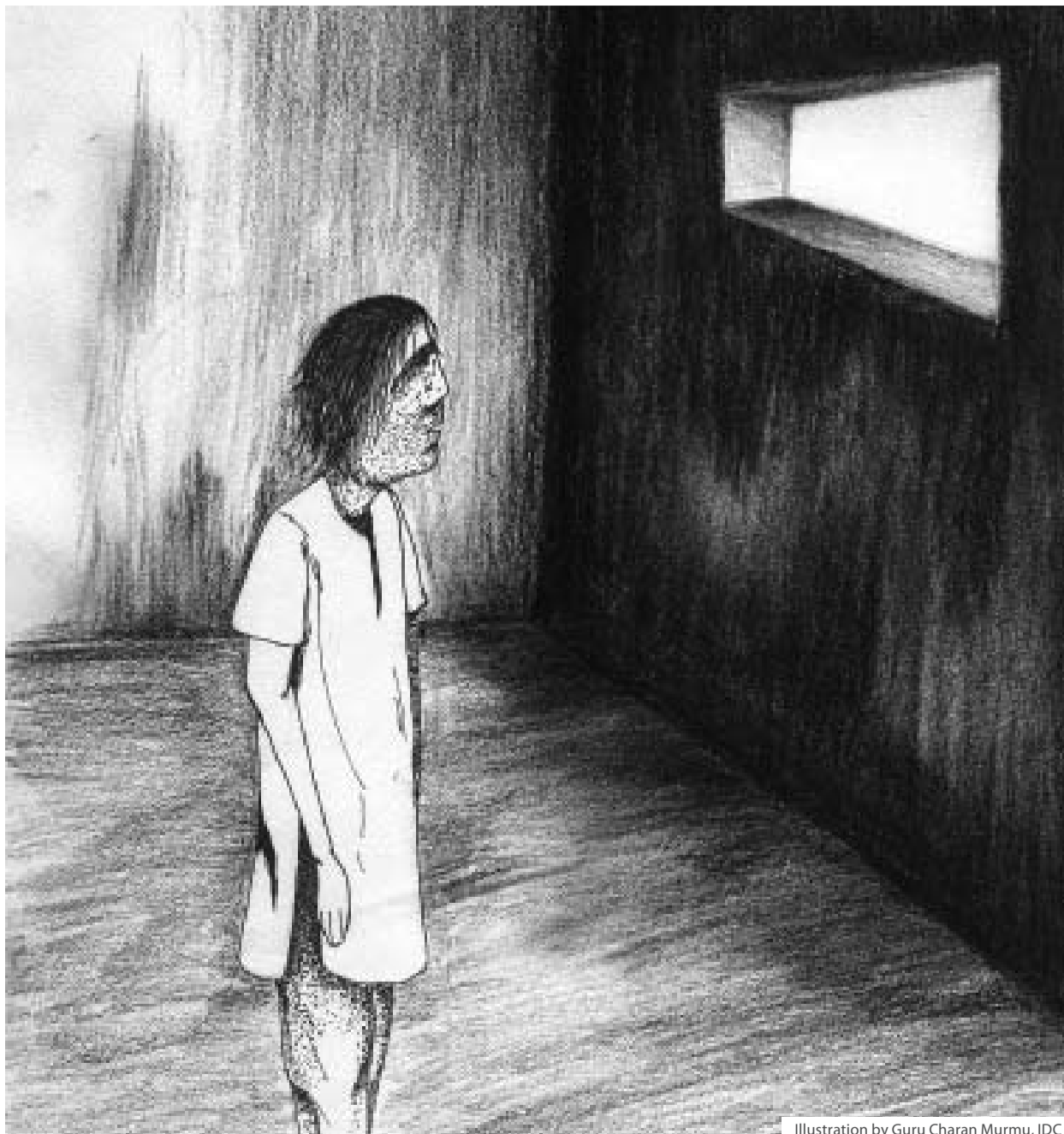

Illustration by Guru Charan Murmu, IDC

My secret life was finally revealed to the general public during my valfi (or valedictorian function – with my consent), with my friends thoughtfully and symbolically having put up my rainbow Pride Flag up on the stage background. I felt a quaint, strange feeling of happiness and light-headedness: I was now officially out of the closet and more so, IIT Bombay's first openly gay student!

A Bed of Roses

Life as a gay person has been exceedingly easy for me. Nearly every single person that I came out to was understanding and sympathetic. (One of my friends, a self-proclaimed homophobe, took a couple of days to come to terms with my homosexuality. All has been chummy between us thereafter.) I am extremely fortunate to come from a liberal, urban family: I'm confident most relatives won't take very long to come to terms with the matter, and they definitely won't disown or disinherit me.

An Appeal

Unfortunately, public awareness in India about homosexuality is abysmal, with the minds of most people choked with myths and misconceptions. Ultimately it boils down to whose opinion you trust – that of the entire world's scientific community or that of a random assortment of clueless babas, preachers and self-proclaimed healers.

Contrary to what the Union Minister for Health, Ghulam Nabi Azad may think, homosexuality is NOT a "disease"! Homosexuality is neither a matter of choice, nor can it be "cured". Homosexuals are not out there to "convert" straight people: you either are gay or you're not, or you're somewhere in between (bisexual, perhaps). Nobody can change anyone's sexual orientation, not even their own!

Section 377 was struck down by the Delhi High Court on 2nd July 2009, finally acknowledging that homosexuality is indeed normal. The verdict notwithstanding, Indian society remains exceedingly cruel to homosexuals and other sexual minorities. All throughout the country – IITB being no exception – homosexuals face a tremendous amount of hostility, ostracism and discrimination. This is the case even among the 'educated elite' of India: just a glance at the countless bitter, hate-filled comments one reads following any article about homosexuality on the internet sends shivers down my spine. Imagine what the case would be in more conservative sections of the Indian society!

A widespread misconception is that homosexuality is a western import. The truth is that there are and always have been gay people in India, it's just that we've been, until recently, too bloody scared to reveal our sexuality to the cruel Indian society! Why on earth would anybody want to go through the ostracism, mental trauma and castigation that would inevitably ensue? Acceptance of homosexuality, however, is indeed a western import, as is acceptance of widow remarriage, abolition of sati, and countless other social reforms of the 19th and 20th centuries.

Homosexuals are not out there to "convert" straight people. Nobody can change anyone's sexual orientation, not even their own!

Many of us lead frustrated, unhappy lives, and never reach our full potential as human beings. This is a consequence primarily of society's ignorance – the sheer pointlessness of all this suffering astounds me. According to most estimates, somewhere between 4 and 10% of our population is homosexual – this may include your best friends and loved ones. I beg all IITians, please help create an atmosphere where your friends do not have to undergo this terrible oppression! Lift the veil of silence and ignorance, and let there be free and frank discussions on the topic. (Try, at least occasionally, to use the word 'gay' in a non-insulting fashion!)

Accept us for who we are, and then let's all get on with our lives as usual, as healthy, productive members of society.

If You Are Lesbian/Gay/Bisexual/Transgender

The loneliness, confusion and unhappiness that you may be experiencing can often be quite overwhelming, and it is vital you find somebody to talk to, someone in whom you can confide your feelings. Ideally, your immediate family and your best friends should be the first to know.

Unfortunately, it's quite likely you come from an extremely conservative family. Also, the 100% acceptance rate I had with my friends is not always guaranteed. If, however, there are people in your life who you are confident will have no issues, it is strongly recommended you come out to them as soon as possible. Doing so will only strengthen your friendship and make you a much happier person.

There exist numerous faculty members at IITB with a progressive outlook towards sexual minorities[1] for a small sample. The student counsellor at IITB, Mrs. Amita Tagare, is also extremely sympathetic and understanding of the problems faced by LGBT students – she has helped at least one acquaintance of mine come to terms with his sexuality. (Her office is located in the Main Building, 1st floor, right next to the DoSA's office.)

And finally, but most importantly, you might like to join Saathi: a support group for Lesbian, Gay, Bisexual, Transgender and Queer (LGBTQ) people at IIT Bombay. The group is meant to be a safe space for people who're still coming to terms with their sexuality and/or are confused. The principal aim of the group is to help people discover themselves in a comforting and supporting environment along with people who're in the same boat. We understand that many of you may not like to openly acknowledge your sexuality and/or are apprehensive about associating yourselves with people who're open. We respect your concerns: you can be as anonymous as you want. No one will force you to reveal your identity or rush you into coming out to people. Check out www.saathi-iitb.org! ■

1. http://www.sacw.net/article1026.html

ET CETERA

The Lighter Side of R&D at IIT Bombay: An Alumni Perspective

■ **HEMENDRA GODBOLE** Alumnus, B. Tech. (1985)

It is rare to have four literary geniuses from the Class of '85 together in the physical world these days. As if that wasn't enough, Jaya had tasked us to submit an article on 'R&D at IIT Bombay' for Raintree. *I popped that thought to my friends as we waited for the fireworks to light up the skies over San Francisco on the 4th of July.*

Tej: R&D from an alumni perspective is a really short conversation.
Raj: You don't mean our version of R&D – do you? Not for this family-rated article in *Raintree!*
Madan: I think Surd means the real stuff, Raj – as in, 'Research and Development'.
Tej: Well, 50 years, 25,000 alumni – and each has contributed an above-average share of development – be it any field, anywhere. So that takes care of getting at least a B+ in 'development', even when using Prof. KCM or Prof. Kamat's grading system. That leaves us with the 'Research' bit.
Me: Okay, Wise One, show us the way! How well do we score in the 'Research' area?

"Well, 50 years, 25,000 alumni – and each has contributed an above-average share of development – be it any field, anywhere. So that takes care of getting at least a B+ in 'development', even when using Prof. KCM or Prof. Kamat's grading system."

Raj: Let me take that one. Back when you were on campus, what are the three things that you searched for the most?
Madan: The three 'W's, of course! Women, Wine and a Weekend with no assignments due on Monday!
We all got into a synchronised trance at the thought of an entire weekend with no agenda – so much so, that our waitress raised her voice to remind us, that we would have to order something soon, other than just 'water with no ice please'.
Tej: Okay Madan, have you found what you were searching for since 1981?
Madan: In a word? No! But like I did back then, I keep looking. I'm not sure if you three can be honest in answering that question though, given how easily your thoughts get transcribed into Facebook these days, where your spouses get to see other dimensions of your eternal love for them.
Tej: Well, there you go! We are still (re)searching the three 'W's after 25 years! That earns us at least an A on Research! Put the two together – and we have scored huge on 'R&D' as IITB alumni. See? It's not all that heavy and complicated as some make it out to be.
Me: Guys, hang on! No cigar yet! Jaya wants a meaty, 400-word article. We can't simply dismiss her request in 20 words by saying: "We are still researching the three 'W's, and have contributed to Development – hence, IITB alumni score high on R&D!" That is way too short for such a serious topic.
Raj: Well, we have never met Jaya, and she has already labelled the 'batch of 85' as "good for nothing". Unless she is related to Kiran Bedi (of the Delhi police fame), should we really take her seriously?

Illustration by Utkarsh Raut, Second Year Mechanical Engineering

That final statement was hushed by a huge uproar from the crowds outside, as the skies over San Francisco came alive! We leaned forward, relishing the moment and the silence between lifelong friends.

The smiles on the faces of Tej, Raj and Madan helped me realise that 'R&D' isn't necessarily about solving problems of cosmic magnitudes in life.

'R&D' perhaps stands for the 'Remarkable Dosti' that our campus life forged within us. We don't really care how anyone grades us on this form of R&D. We are simply thankful, and celebrate our R&D each day.

A heavier article for Raintree on 'R&D at IIT-Bombay from an alumni perspective' would need a few more beers, or perhaps the wisdom from wiser folks within the alumni ranks – or both! ■

How to Write a Scientific Paper

■ *Below are excerpts from a blog post written by* **DR E. ROBERT SCHULMAN**, VIRGINIA UNIVERSITY USA

Abstract
We (meaning I) present observations on the scientific publishing process which (meaning that) are important and timely in that unless I have more published papers soon, I will never get another job. These observations are consistent with the theory that it is difficult to do good science, write good scientific papers, and have enough publications to get future jobs.

1. Introduction
Scientific papers (e.g. Schulman 1988; Schulman & Fomalont 1992; Schulman, Bregman, & Roberts 1994; Schulman & Bregman 1995; Schulman 1996) are an important – though poorly understood – method of publication. They are important because without them scientists cannot get money from the government or from universities. They are poorly understood because they are not written very well (see, for example, Schulman 1995 and selected references therein).

An excellent example of the latter phenomenon occurs in most introductions, which are supposed to introduce the reader to the subject so that the paper will be comprehensible even if the reader has not done any work in the field.

Nominally, science involves discovering something new about the universe, but this is not really necessary. What is really necessary is a grant.

The real purpose of introductions, of course, is to cite your own work (e.g. Schulman et al. 1993a), the work of your advisor (e.g. Bregman, Schulman, & Tomisaka 1995), the work of your spouse (e.g. Cox, Schulman, & Bregman 1993), the work of a friend from college (e.g. Taylor, Morris, & Schulman 1993), or even the work of someone you have never met, as long as your name happens to be on the paper (e.g. Richmond et al. 1994). Note that these citations should not be limited to refereed journal articles (e.g. Collura et al. 1994), but should also include conference proceedings (e.g. Schulman et al. 1993b), and other published or unpublished work (e.g. Schulman 1990). At the end of the introduction you must summarise the paper by reciting the section headings. In this paper, we discuss scientific research (section 2), scientific writing (section 3) and scientific publication (section 4), and draw some conclusions (section 5).

2. Scientific Research
The purpose of science is to get paid for doing fun stuff if you're not a good enough programmer to write computer games for a living (Schulman et al. 1991). Nominally, science involves discovering something new about the universe, but this is not really necessary. What is really necessary is a grant.

In order to obtain a grant, your application must state that the research will discover something incredibly fundamental. The grant agency must also believe that you are the best person to do this particular research, so you should cite yourself both early (Schulman 1994) and often (Schulman et al. 1993c). Feel free to cite other papers as well (e.g. Blakeslee et al. 1993; Levine et al. 1993), so long as you are on the author list.

Once you get the grant, your university, company, or government agency will immediately take 30 to 70% of it so that they can heat the building, pay for Internet connections, and purchase large yachts. Now it's time for the actual research. You will quickly find out that (a) your project is not as simple as you thought it would be and (b) you can't actually solve the problem. However – and this is very important – you must publish anyway (Schulman & Bregman 1994).

3. Scientific Writing
You have spent years on a project and have finally discovered that you cannot solve the problem you set out to solve. Nonetheless, you have a responsibility to present your research to the scientific community (Schulman et al. 1993d). Be aware that negative results can be just as important as positive results, and also that if you don't publish enough you will never be able to stay in science. While writing a scientific paper, the most important thing to remember is that the word "which" should almost never be used. Be sure to spend at least 50% of your time (i.e. 12 hours a day) typesetting the paper so that all the tables look nice (Schulman & Bregman 1992).

4. Scientific Publishing
You have written the paper, and now it is time to submit it to a scientific journal. The journal editor will pick the referee most likely to be offended by your paper, because then at least the referee will read it and get a report back within the lifetime of the editor (Schulman, Cox & Williams 1993). Referees who don't care one way or the other about a paper have a tendency to leave manuscripts under a growing pile of paper until the

Illustration by Jaya Muthu, IDC

The conclusion section is very easy to write: all you have to do is to take your abstract and change the tense from present to past.

floor collapses, killing the 27 English graduate students who share the office below. Be aware that every scientific paper contains serious errors. If your errors are not caught before publication, you will eventually have to write an erratum to the paper explaining (a) how and why you messed up and (b) that even though your experimental results are now totally different, your conclusions needn't be changed.

Errata can be good for your career. They are easy to write, and the convention is to reference them as if they were real papers, leading the casual reader (and perhaps the Science Citation Index) to think that you have published more papers than you really have (Schulman et al. 1994).

5. Conclusions
It is considered good form to mention at least one relevant theory only in the abstract and conclusion. By doing this, you don't have to say why your experiment does (or does not) agree with the theory, you merely have to state that it does (or does not).

We (meaning I) presented observations on the scientific publishing process which (meaning that) are important and timely in that unless I have more published papers soon, I will never get another job. These observations are consistent with the theory that it is difficult to do good science, write good scientific papers, and have enough publications to get future jobs.

Raintree Wins ICE Awards
After winning the prestigious Association of Commonwealth Universities PR Award, 2011, *Raintree* has once again won the In-house Communication Excellence (ICE) awards in two categories: 'Best Content' and 'Best In-House Magazine' (in India). It won a gold (first position) in both the categories. The awards carried trophies and cash prizes.

In-house Communication Excellence (ICE) awards are popular awards bestowed for internal communications in the corporate and academic world. This year, there were 497 entries in total including the Taj group, Vijay Mallya's UB Group, Nestle, Government Law College, National Institute of Design, Nabard, HT Media, Raj Bhavan Mumbai and the Reserve Bank of India.

Raintree team receiving ICE awards

Make Hostel My Home
IIT Bombay Alumni Association, as part of its decennial celebrations is all set to launch a brand new programme, Make Hostel My Home to improve the living conditions of students in the hostels. Make Hostel My Home or MH*2, as it is popularly known amongst hostelites, aims to encourage and empower students to improve their living environment and facilities. It seeks to address the issue of overcrowding in the hostels, general wear and tear of old buildings and maintenance in a positive, proactive fashion.

The idea behind MH*2 is that an elected student body would conduct periodic audits of the hostel facilities to develop an actionable correction plan, put up notices and post photos on the web for full visibility, which will make it easier for the council and concerned authorities to act. While students will take up the task of keeping their immediate surroundings clean of debris and detritus, the alumni will step in to fund infrastructural improvements. Alumni under HATS would establish a rotating trophy, for which students and alumni would vote and collectively award to the best hostel on campus, based on cleanliness and facilities. The MH*2 trophy would be collectively handed over at the Common HATS gala dinner on Alumni Day.

Solar Thermal Power Plant Simulator
Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy, Government of India, inaugurated the preliminary version of the Solar Thermal Power Plant Simulator developed by IIT Bombay on July 25, 2011. Prof. Devang Khakhar, Director, IIT Bombay was present on the occasion. The event is related to the project entitled, 'Development of a Megawatt-scale Solar Thermal Power Testing, Simulation and Research Facility.'

IITB Alumnus Plans Village Knowledge Centres for Children
After a successful execution of a programme to provide children in a village in Karnataka with access to knowledge of English and internet connectivity for six years, Bangalore-based Affordable Business Solutions is planning to start eight more Village Knowledge Centres (VKCs) in the area. "We want to create a hub of ten or more VKCs in rural Karnataka and replicate the model elsewhere," said CEO Shrikant Rao, an alumnus of IIT Bombay. VKCs act as nodal centres for knowledge connectivity. It provides information such as new ways of farming, employment opportunities, prices of agricultural commodities, as well as facilities such as internet banking, railway bookings. "Our focus has been to provide the facilities for school-going children. Recently, many adults were demanding that they be taught how to use the computer, English, and internet", said Mr. Rao. Currently, two VKCs are operating in Ittamadu village benefiting 800 children. The eight proposed VKCs will be in Ittamadu and a neighbouring village, Melgopahalli. The Bangalore Chapter of IITB's Alumni Association is helping the organisation raise funds for this project. ■

SHORT FEATURE

The Journal of Misfit Papers

■ **BISWA PRASUN CHATTERJI** Research Scholar, Biosciences & Bioengineering Department

My article is about how I found two journals who accept papers vetoed by other journals in the field, or results for which there are no takers, or when you question current practices. This sprang from the frustration a scientist feels when his or her paper is summarily overruled, or after thorough peer review and its remedy. When overcoming the dejection of having my first paper being returned by a journal, a colleague kindly counselled me by saying, "Welcome to the real world of science, you have just arrived." Later on, when I had eventually published my work in another journal, I tried to seek avenues for publishing an unaccepted paper per se. Voila! I found these two unusual journals.

One such journal is 'Rejecta Mathematica'.[1] It publishes mathematics papers. It has a nice editorial on the rejection-acceptance cycle predominating scientific publications in its inaugural issue[†]. Their requirements are that "submitted research manuscripts must have been previously rejected from a peer-reviewed journal in the mathematical sciences," and that the manuscript must accompany an open letter from the authors stating the full procedure of peer review and final rejection by the previous journal. If you are very disgruntled with your field of research, then they are ready to help you to start a 'Rejecta' journal in your field!

Another is the 'Journal of Negative Results in Biomedicine'.[2] As the name suggests, it publishes articles on clinical trials or pharmaceutical sciences. This journal is published by BioMed Central, an open-access publisher of 220 peer-reviewed journals. The impact factor of this journal is 1.10. The impact factor of a journal indicates how many times an article is cited by readers in a given time. The higher the impact factor of a journal, the better its acceptability. This journal publishes failed clinical trials as well as existing or promising drug molecules which fail to live up to their expectations.

An example of such a paper is on the lack of effect of anti-cholesterol drugs[‡] Statins are cholesterol-lowering drugs used to treat patients with cardiovascular diseases. However, this particular article published in this journal of negative results in 2011 showed that continued use of statins in Swedish populations between 1998 and 2002 did not lower any incidence of cardiovascular diseases or mortality rate. It is to be noted that this journal has been publishing such papers for the past ten years.

One such journal is 'Rejecta Mathematica'. If you are very disgruntled with your field of research, then they are ready to help you to start a 'Rejecta' journal in your field!

You may find their approach surprising, amusing or weird, but don't forget that sometimes, there is no balm more soothing for your bruised ego than a publication to announce your efforts in science.

But the purpose of publishing negative results goes deeper. Sometimes the negative results obtained by the researchers can prevent others from redoing the same experiments or alert others about futility of certain medicines. Any failures of medicines in clinical trials need to be known by the doctors and scientists to avoid future use. Many potential drug molecules in clinical trials show severe side-effects in patients. It is also very frequently seen that pathogens develop resistance to antibiotics, anticancer, anti-parasitic or antifungal drugs. Bacteria resistant to antibiotics after rampant use or cancer cells resistant to anticancer drugs are not unknown. Quite

Sometimes the negative results obtained by the researchers can prevent others from redoing the same experiments or alert others about futility of certain medicines.

often, transgenic plants carrying pesticide genes grow resistant to the pests over the time.

Journals for publishing negative results in life science or medicine can successfully make the scientific community aware of these particular failures discussed above, such as side-effects, or the development of resistance. Sometimes journals specialising in printing rejected publications can offer a contrarian view of present models to the scientific community, and also alert fellow scientists which way to go or avoid.

Journals which publish rejected papers or negating results about medical or biotechnological use of drugs or proteins can carve a niche in the widely-expanding repertoire of scientific journals. ■

References:
†. Letter from the editors. (2009) Rejecta Mathematica Vol. 1, No. 1, pp. 1-3
‡. Nilsson S, Mölstad S, Karlberg C, Karlsson JE and Persson LG. (2011) No connection between the level of exposition to statins in the population and the incidence/mortality of acute myocardial infarction: An ecological study based on Sweden's municipalities. Journal of Negative Results in BioMedicine , 10:6 (24 May 2011) ■

1. http://math.rejecta.org/
2. (http://www.jnrbm.com/)

AWARDS

PROF. CHETAN SOLANKI Department of Energy Science and Engineering, has received the first prize (₹50,000 and a certificate) from the Ministry of New and Renewable Energy (MNRE), Govt. of India, for his book on renewable energy in Hindi. The title of the book is *Akshay Urja Praudhyogiki – Ek Vyavaharik Gyan* and it has been published by Prentice Hall of India.

PROF. H. B. SINGH Department of Chemistry, has been chosen to receive the CRSI silver medal in recognition of his outstanding contribution to research in Chemistry.

PROF. PUSHPAK BHATTACHARYYA Department of Computer Science and Engineering, has been awarded a $10,000 Yahoo! Faculty Research and Engagement award for a proposal he had sent in his area of Machine translation. The award is in the form of an 'unrestricted gift'.

PROF. D. N. SINGH Department of Civil Engineering, has been awarded the 'John R. Booker Excellence Award, 2011' for the advancement of research, education and practice of Environment Geotechnology and development of novel techniques to simulate contaminant transport in geomaterials under laboratory and in-situ conditions. He has also been elected as Fellow of the American Society of Civil Engineers.

PROF. SUBHASIS CHAUDHURI Department of Electrical Engineering, has been selected for the prestigious 'G.D. Birla Award for Scientific Research' for his important contributions in the area of electronic communications.

PROF. KRISHNA JONNALAGADDA Department of Mechanical Engineering, has been awarded the Hetenyl Award for the best research paper in Experimental Mechanics. His paper is entitled 'Experimental Investigation of Strain Rate Dependence of Nanocrystalline Pt Films'.

PROF. M. RAVIKANTH Department of Chemistry has been chosen to receive the 'CRSI Bronze Medal' in recognition of his contributions to research in Chemistry.

PROF. HARIPRIYA GUNDIMEDA Department of Humanities and Social Sciences, has been made a member of a high-level expert committee set up by the Government of India to prepare the road map for developing Green National Accounting for India. This is in recognition of her work in carrying out green accounting for select sectors in India.

PROF. AZIZUDDIN KHAN Department of Humanities and Social Sciences, has been awarded 'ICMR International Fellowship for young Bio-Medical Scientists' for the year 2011-2012.

COLLOQUIA

PROF. M. S. NARASIMHAN (FRS, King Faisal Prize), Tata Institute of Fundamental Research, Mumbai, spoke on 'What Do Mathematicians Do and How?' at the Institute Colloquium on March 28, 2011.

PROF. JOSÉ RUIZ-HERRERA Emeritus Professor, Centro de Investigación y de Estudios Avanzados, México, spoke on 'Fungi as Models for the Molecular Analysis of Cell Differentiation: The Dimorphic Phenomenon', at the Institute Lecture on March 31, 2011.

DR ROBERT (BOB) S. ANDERSSEN Senior Principal Mathematician, CSIRO Mathematics, Informatics and Statistics, Australia, spoke on 'Modelling Information Recovery – The Near Infrared Technological Revolution', at the Institute Lecture on April 6, 2011.

PROF. P. N. BARTLETT Professor of Electrochemistry, School of Chemistry, University of Southampton, UK, spoke on 'SERS on Nanostructured Surfaces and Application to DNA Detection and Discrimination', at the Institute Lecture on May 20, 2011.

MS ORNA SAGIVE Consul General of Israel, Israel Consulate, Mumbai, spoke on 'Bilateral Relations between India and Israel', at the Institute Lecture on May 25, 2011.

COSMONAUT SAVINYKH VICTOR PETROVICH Russian Centre for Science & Culture, Russia, spoke on 'Space Travel', at the Institute Colloquium on June 10, 2011.

DR RAVI KANNAN Principal Researcher, Algorithms Research Group, Microsoft Research Laboratories, India, spoke on 'Vectors, Probability and Algorithms', at the Institute Colloquium on July 26, 2011.

PROF. P. R. KUMAR Franklin W. Woeltge Professor, Department of Electrical and Computer Engineering, University of Illinois, Urbana-Champaign, spoke on 'Challenges in Cyberphysical Systems', at the Institute Lecture on July 27, 2011.

PROF. RAGHURAM MURTUGUDDE Professor, Department of Atmospheric and Oceanic Science, and Executive Director, Earth System Science Interdisciplinary Center, University of Maryland, College Park (UMCP), USA, spoke on 'Predictions to Solutions: Role of Technology in Facing Change', at the Institute Colloquium on August 3, 2011.

IIT Bombay Auctions Innovative Games for Education and Entertainment

An auction of games was done on July 7, 2011, to which industries involved in child education as well as toys and games companies were invited to let the games have a much wider audience and reach. 14 games, designed by students of IDC in collaboration with Electrical engineering students were put on auction on that day. These board and electronic games involve a good mix of strategic thinking, problem solving, education, dexterity, talent analysis and a bit of luck. For example, 'Lumino Trapz' and 'Delta Attack' are based on strategic thinking, 'Magneteyez' and 'Feel Fill Fit' designed to develop visualisation. 'Cric-Tric' develops cricket-specific strategic thinking, while 'Wobble' and 'Over-the-top' test the sense of balance. There are also educational games like 'Roll it Green', which teaches children about the green initiative and 'Chuna Chunao' and 'Ulitipolity' explaining how the parliamentary system works. 'Trade Raid' is a rapid card game and involves fun, shouting, grabbing and develops quick responses.

Speaking on the announcement, Prof. Uday Athavankar of IDC said: "There is a need to invent new playing possibilities in the games for children to interest and educate them. Over the years, the games designed by students have been picked up by various toy and games manufacturing companies (like Funskool) so that they can be marketed and made available to everyone. This is the first effort to open this scheme to all the toys and games manufacturers." Prof. Athavankar has specialised in the area of designing games, puzzles and products.

Prof. Subhasis Chaudhuri of Electrical Engineering Department who has been spearheading research in the area of haptics at IITB added, "Haptics – which means 'the science of touch' – is a new technology that augments this experience with tactile feedback and helps in providing an excellent hapto-visual immersion of the user into the game. At IITB, we are exploring the use of this new technology to develop interactive games that are both entertaining and educative. Additionally, we are using some of these games to study certain perceptual effects in human subjects. We expect these games to be very popular within a short span of time."

Rise in IITB students opting for R&D Jobs

With the economy is increasingly striving for high-end products and services, a larger number of companies are now striving to develop products on the forefront of technology. IIT Bombay saw an increase in organisations hiring fresh graduates in the R&D sector. This sector has been steadily growing for the past few years and this year, the institute saw some premier job offers in this sector. A total of 16 R&D organisations offered around 69 positions this year, up from 54 last year.

"The R&D sector has been steadily growing for the past few years and interest among our students in research profiles has also increased. Besides an increase in the number of organisations hiring fresh graduates in the R&D sector, the nature of jobs being offered have changed. The profiles offered are not just top-notch and specialised, but also very exciting. The compensation won't be as high as a job in financial, software and some engineering sectors, but that's not deterring the students," said Prof. Ravi Sinha, professor-in-charge, Placements, IITB.

Mood Indigo 2010 winners perform at NCPA

In line with Mood Indigo's ideology of promoting talent, the winners of the dramatics competitions at Mood Indigo 2010 got a golden opportunity to perform at the National Centre for the Performing Arts (NCPA), the most prestigious stage for performing arts in India. These plays were performed in the Dance Theatre Godrej at NCPA on June 27, 2011.

The plays that were showcased were *Hawalat* by IIT Bombay, *The Complete Works of William Shakespeare (Abridged)* by St. Xaviers College and *Disha – a street play* by Shivaji College, coming all the way from Delhi to perform here. These plays were judged as the best ones from more than 100 entries in the street play and one-act play competitions in Mood Indigo 2010, from the top colleges across the country. They were judged by eminent personalities in this field such as Kamlesh Pandey, Himani Shivpuri, Viju Khote and Amit Behl.

"It was the most amazing experience winning at Mood Indigo, and getting the chance to perform at NCPA. It is like a dream come true!" said Saaransh Thareja, Shivaji College, Delhi, runners-up of Aagaaz, the street play competition held in Mood Indigo 2010.

Mr. Khushroo N. Suntook, Chairman, NCPA, says, "We are delighted to partner with Mood Indigo, one of the most popular college festivals of Mumbai. At the NCPA, we have always made an attempt to give a platform to young performers though a range of programmes, educational initiatives and collaborations. IITB has an enterprising batch of students who have put this great festival together and, as India's premier arts and culture institution, it was imperative that NCPA be the venue for their Dramatics Competition winners. We wish them luck in this endeavour."

Medicinal Garden

A medicinal garden was recently inaugurated through the efforts of the Green Campus Initiative Committee of IIT Bombay. Prof. K. V. K. Rao, Dean (IPS), and the members of the committee were present on the occasion. Saplings of about 70 species of medicinal plants were planted. The garden is situated adjacent to the Department of Mechanical Engineering.

Planting medicinal saplings

E-Cell helps Budding Entrepreneurs

While getting funds or mentorship is a huge challenge for a new venture, help is now at hand for students at IITB. A student at any stage of a start-up will soon be able to approach the entrepreneurship and business club, which was recently launched by the Entrepreneurship Cell (E-Cell). "We intend to help aspiring entrepreneurs on campus at various stages of a start-up. Students can approach us and we will short-list valid plans and provide them resources and funds. They will get an objective feedback from experts on parameters like scope of the venture, market and customer analysis and financial implications, among others," said Ayush Agrawal, manager of E-Cell.

Last year, the institute had launched a programme called 'E-Garage', which was aimed at nurturing ideas and hatching businesses on campus. A collaborative effort of the E-Cell, Shailesh J. Mehta School of Management and Society for Innovation and Entrepreneurship (SINE), it aimed at establishing a connection between technology and management. The club is a step forward in that direction, involving activities like case-study sessions and business simulation.

The club will have sessions to explain to students the nuances of entrepreneurship. An integral activity will be students' day out where they will get a chance to work with successful entrepreneurs, chief executive officers, founders and big businessmen for a day.

"They will get a taste of the challenges involved and how to go about one's work. Students can then take an informed decision whether they still want to seek a job or start something of their own," said Radhika Goel, E-Cell's media manager.

Alumni Turn into Philanthropists

Mr. N. P. Verghese, 67, was a hostel mess worker for 34 years. He retired in 2002 and is settled in Kerala. Three months back, Mr. Verghese was advised to undergo a prostate surgery that would cost him ₹75,000. Since he could not afford this, he turned to the only place he could think of for help – the IIT Bombay Alumni Association, which granted him ₹50,000 within two days. This money was paid through IITB's Benevolent Fund which supports the IIT community in times of calamity. Even though the fund has collected only ₹10 lakhs from the time it was set up three years ago, it has already helped 12 people. Now, the association which turns ten this year, is looking at expanding the fund as part of their decennial year plans. "We want more alumni to contribute to the fund. The fund has been beneficial to several people and there are many more who can benefit from it," said Bakul Desai (alumnus, 1982).

IITB wins 'Tower of Babylon' Competition

IITB has been declared the winner of the 'Tower Of Babylon', an interdisciplinary competition among five members of the Global Alliance of Technological Universities, viz., IIT Bombay, ETH Zurich, Georgia Institute of Technology, Atlanta, NTU, Singapore and SJTU Shanghai, China.

The competition was a global sustainability challenge organised by the Global Alliance of Technological Universities. The students had to design a tower representing sustainability using only local materials and hands-on knowledge, within a limited budget of US $1,000. Drawing from Indian culture, the students created a kettle-shaped rain harvesting structure. Efforts of students were appreciated globally and the team won the first prize in the competition, and individual prizes in the topic, design and representation criteria. Complete details of the competition along with the video footage can be found at *http://www.towerofbabylon.org*.

JEE Toppers opt for IIT Bombay

Till about a decade ago, IIT Kanpur was the preferred destination not only of the JEE top 100, but of most engineering aspirants in the country. But IIT Bombay has now risen in favour. 70 of the top 100 rankers in JEE 2011 have joined IITB. A number of factors have worked in favour of IITB, including location, food, placement record and the influence of coaching classes. "Students feel that IIT Bombay is academically good and they can grow as persons here," said IITB's JEE Chairman, Avijit Chatterjee.

PROF. N. S. PUNEKAR was appointed as Head, Department of Biosciences & Bioengineering, on June 1, 2011.

DR S. MAHESWARAN joined as an Assistant Professor in the Department of Chemistry on March 31, 2011.

DR AVIK BHATTACHARYA joined as an Assistant Professor in CSRE on May 2, 2011.

DR SURYA DURBHA joined as an Assistant Professor in CSRE on April 27, 2011.

RETIREMENTS

DR P. SUBHADRA RAMACHANDRAN retired after 33 years of service on April 30, 2011. She worked as a Senior Programmer in the Department of Computer Science & Engineering.

Dr Subhadra, in her career of over 33 years, has served the institute with distinction. Along with a bunch of young TAs and RAs, all mentored by her, she has been handling the task of system administration in the Department of CSE with rare competence. This has resulted in the smooth running of laboratories and other computing facilities. Dr Subhadra has also played a leading role in the design, development, and operation of data processing systems for JEE and GATE examinations.

The institute wishes Subhadra a long and happy life after retirement .
Dr. D.B. Phatak, Department of Computer Science & Engineering

SHRI RAMESH D. CHHATLANI retired after 37 years of service on April 30, 2011. He worked as a Superintendent in the Cash Section.

Shri R. D. Chattlani was a very cheerful with positive attitude towards life. He was very friendly with all HIS colleagues. He interacted with the staff and faculty very politely and was always helpful to all. Whenever a job was assigned to him, he accomplished the same efficiently and with great enthusiasm.

Best wishes to him and his family for a very happy and long retired life.
Shri S. D. Dalvi, In-charge, Cash-Section

SHRI SUDHIR MANE retired after 25 years of service on April 30, 2011. He worked as a Security Officer, Security Section.

MS BALAMANI VELUSAMY retired after 33 years of service on April 19, 2011. She worked as a Junior Superintendent, Material Management Division.

MS MARIE VARGHESE retired after 37 years of service on May 31, 2011. She worked as a Superintendent in the Dean (R&D) office.

'Sincere', 'hard-working', 'dedicated' are some of the words one would use to describe Ms Marie Varghese, who worked in IRCC for more than three decades. She mainly dealt with activities related to consultancy projects like preparing letters, keeping track of payments received and lending support to the faculty in any other matter related to their consultancy. She was mainly responsible for the smooth functioning of consultancy section and record keeping. A sense of responsibility reflected in her approach to her work and this is evident from the fact that she has trained her successor very well.
Ms Manjiri Marathe, Office of Dean (R&D)

SHRI ATMARAM D. KAMBLE retired after 29 years of service on May 31, 2011. He worked as an Attendant (SG) in the Department of Chemical Engineering.

Shri A. D. Kamble stood out with his immense dedication to his work, his commitment to his job and his willingness to help others, specially the students associated with teaching and research laboratories across several generations. He played a tremendous role in managing laboratory equipment safely, ranging from the antiquated Russian rigs we inherited to the sophisticated ones we got in recent times. He went that extra mile to help others, particularly by using his extensive network of useful friends in the institute. Above all, he had a positive and practical outlook to life which he tried to rub off on all those he came into contact with. His services will be missed.
Mr. Jitendra S. Kocharekar, Adm. Assistant to Prof. Jayesh Bellare, Silicate Lab, Chemical Engineering Department

SHRI NIGAPPA C. HUGAR retired after 32 years of service on May 31, 2011. He worked as a Library Information Officer in the Central Library.

A soft-spoken person with pleasing personality, Mr. N. C. Hugar will be fondly remembered by all his colleagues

and friends. He had a deep sense of devotion while serving the users of the library. We all wish him a happy and healthy post-retirement life.
Mr. Daulat Jotwani, Librarian, Central Library

SHRI JANARDHAN B. MUNGEKAR retired after 32 years of service on May 31, 2011. He helped as a Helper (SG) in the Department of Aerospace Engineering.

G. B. Mungekar was known for his calm and friendly disposition. We wish him a peaceful retired life.
Mr. Vishal Karnekar, Department of Aerospace Engineering

MS MANJULABAI R. SOLANKI retired after 32 years of service on May 31, 2011. She worked as a Senior Cleaner in the IIT Hospital.

Ms Manjulabai Solanki's association with the hospital will be remembered by our staff members as pleasant and fruitful due to her non-complaining and helping nature.
Dr. Nisha Shah, CMO, IIT Hospital

SHRI PRAKASH N. PAWAR retired after 30 years of service on May 31, 2011. He worked as a Superintendent in the Academic Section.

SHRI PRAKASH R. VAIDYA retired after 33 years of service on May 31, 2011. He worked as a Proof Reader (SG) in the Printing Press.

SHRI VASANT K. DALVI retired after 39 years of service on May 31, 2011. He worked as a Junior Technical Superintendent in the Department of Earth Sciences.

SUBHASH H. YADAV retired after 35 years of service on May 31, 2011. He worked as Mechanic Assistant in the Department of Mechanical Engineering.

He was very good at servicing the engine components and systems and worked dedicatedly throughout the service time.
Prof. S.L. Bapat, Head, Mechanical Engineering Department

MS KAMUBAI M. SOLANKI retired after 35 years of service on June 30, 2011. She worked as a Cleaner (SG) in the IIT Hospital.

Ms Kamubai Solanki has put in several years of selfless service to the community through the hospital. The hospital staff will remember her as sincere and hard-working person.
Dr. Nisha Shah, CMO, IIT Hospital

PROF. K. G. NARAYANKHEDKAR retired after 41 years of service on June 30, 2011. He was a professor in the Department of Mechanical Engineering.

Prof. Narayankhedkar joined the department in 1970 as an Associate Lecturer. He was promoted to the post of Professor in 1983 and served as the Dean (Planning) for two terms during 1995-2001. He was also the Convener, School for Cryogenic Engineering, since 1977. He took over as Director, VJTI Mumbai, on 29th December 2005.
Prof. S.L. Bapat, Head, Mechanical Engineering Department

MR. SHIVAJIRAO M. PATIL retired after 37 years of service on June 30, 2011. He worked as a Senior Superintendent in the Academic Section.

SHRI DATTA R. JOSHI retired after 38 years of service on June 30, 2011. He worked as a Senior Superintendent in the CEP & QIP Section.

Shri D.R. Joshi, fondly known as Datta Joshi in the institute, has served for close to four decades in various capacities. The last eight years of his service has been at the CE & QIP office, where he has left his unmistakable mark of efficiency and professionalism. He has also mentored his juniors and motivated them to perform not only up to their potential, but even beyond it. The CE & QIP family wishes Mr. Datta Joshi all the very best of

health and success in whatever he chooses to undertake.
Prof. Ashok Joshi, Professor-in-charge, CE & QIP

SHRI DEVKISAN TIDKE retired after 33 years of service on June 30, 2011. He worked as a Helper (SG) in the Estate Office

MS VEENA BHATIYA retired after 25 years of service on June 30, 2011. She worked as a Library Information Officer in the Central Library.

Ms Veena S. Bhatia was very humble, quiet and devoted person, always willing to help every reader that approached her. She was also very active participant in social activities held on the campus. All her colleagues and friends wish her a happy, healthy and peaceful life.
Mr. Daulat Jotwani, Librarian, Central Library

MR. CHANDRAKANT B. MORE retired after 39 years of service on June 30, 2011. He worked as a Superintendent in Electrical Maintenance Division,

Mr. More was responsible for billing and payments. He worked very honestly and punctually. His contribution to the section and the institute is well-appreciated. We wish him the best in life.
Mr. B. K. Sahoo, Executive Engineer, Electrical Engineering Department

SHRI VASANT R. LAD retired after 39 years of service on June 30, 2011. He worked as a Peon (SG) in the Administration Section.

MR. SHRIPAT S. KOLAPTE retired after 33 years of service on June 30, 2011. He worked as a Helper (SG) in the Estate Office,

Mr. S. S. Kolapte was looking after the maintenance in the Hostel Area. He was a deeply sincere and self-motivated worker, a rarity to come across these days in any sector. He is fondly missed by all. We wish him a fulfilling and restful life ahead.
Mr. V. B. Mamdapur, Superintendent Engineer, Estate Office

MS SHAKUNTALA R. RAMUGADE retired after 32 years of service on June 30, 2011. He worked as a Senior Cleaner in the Campus School.

SHRI SURESH TUKARAM BHUWAD retired after 35 years of service on June 30, 2011. He worked as an Attendant (SG) in the Department of Mechanical Engineering.

He spent many years supporting the stores activities under Shri Acharya as the Stores-in-Charge. His soft language and strict vigil on the papers made him a very well accepted person with the staff/faculty and students.
Prof. S.L. Bapat, Head, Mechanical Engineering Department

SHRI BAHADUR SINGH N. retired after 36 years of service on June 30, 2011. He worked as a Watchman (SG) in the Security Section.

SHRI YESHWANT S. SHIKHARE retired after 38 years of service on July 31, 2011. He worked as a Mechanical Assistant in the Department of Mechanical Engineering.

He handled the charge of the departmental library for a good number of years.
Prof. S.L. Bapat, Head, Mechanical Engineering Department

SHRI SHIVRAM K. PATARE retired after 31 years of service on July 31, 2011. He worked as a Senior Helper in the Electrical Maintenance Division.

Mr. S. K. Patare was punctual and honest. His contribution to the section and the institute is gratefully appreciated.
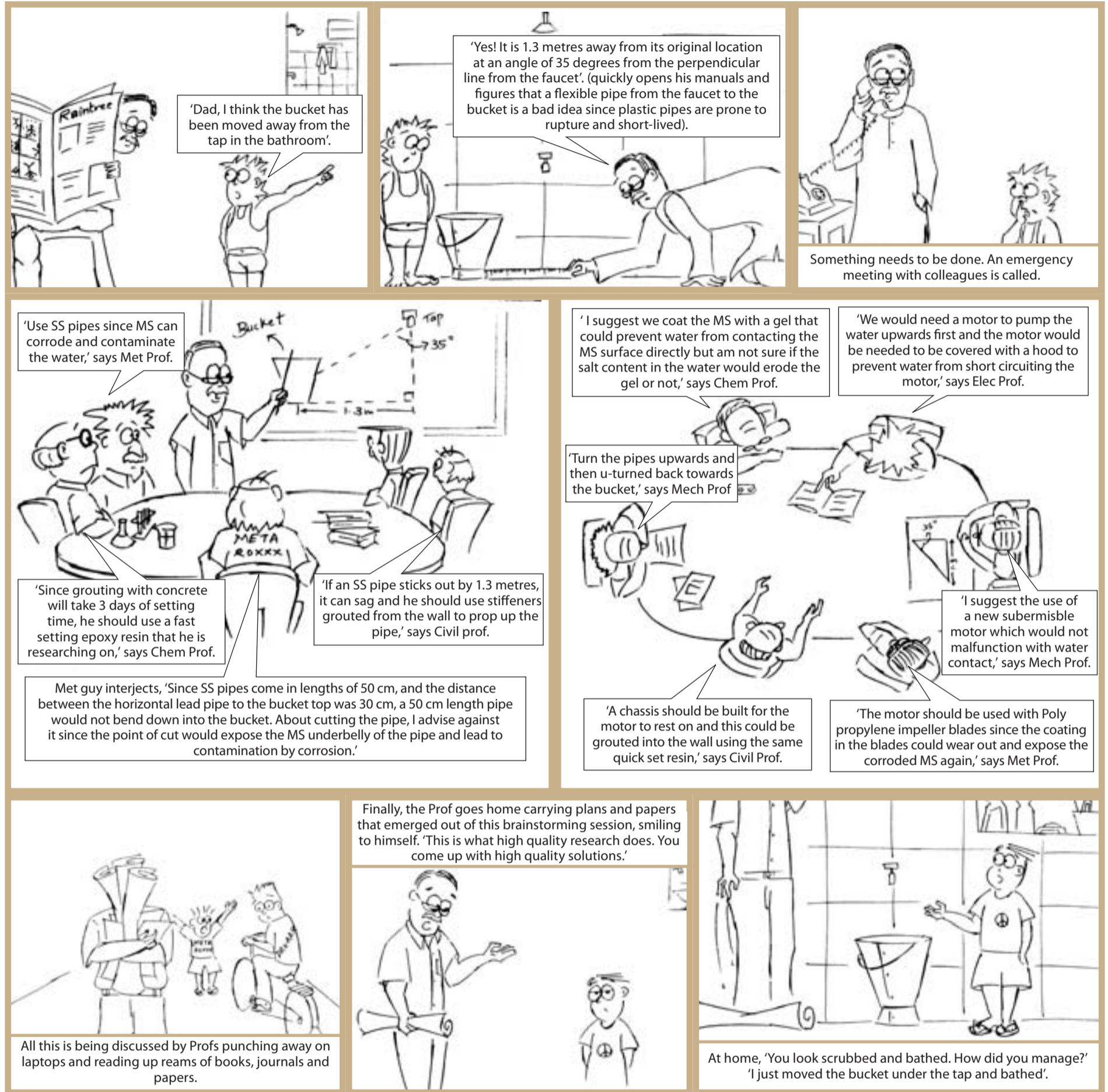**Mr. B. M. Kamble, Assistant Engineer, Electrical Maintenance Division**

PHOTO-ESSAY # The Bucket Case

■ Concept: **BAKUL DESAI**, Alumnus, B. Tech. (1982) | Illustrations: **UTKARSH RAUT,** Second Year Undergraduate Student, Mechanical Engineering

Presenting the curious case of the bucket in the bathroom, which a professor's son and five professors solved in an ingenious way — the IIT Bombay style. ■

'Dad, I think the bucket has been moved away from the tap in the bathroom'.

'Yes! It is 1.3 metres away from its original location at an angle of 35 degrees from the perpendicular line from the faucet'. (quickly opens his manuals and figures that a flexible pipe from the faucet to the bucket is a bad idea since plastic pipes are prone to rupture and short-lived).

Something needs to be done. An emergency meeting with colleagues is called.

'Use SS pipes since MS can corrode and contaminate the water,' says Met Prof.

'Since grouting with concrete will take 3 days of setting time, he should use a fast setting epoxy resin that he is researching on,' says Chem Prof.

'If an SS pipe sticks out by 1.3 metres, it can sag and he should use stiffeners grouted from the wall to prop up the pipe,' says Civil prof.

Met guy interjects, 'Since SS pipes come in lengths of 50 cm, and the distance between the horizontal lead pipe to the bucket top was 30 cm, a 50 cm length pipe would not bend down into the bucket. About cutting the pipe, I advise against it since the point of cut would expose the MS underbelly of the pipe and lead to contamination by corrosion.'

' I suggest we coat the MS with a gel that could prevent water from contacting the MS surface directly but am not sure if the salt content in the water would erode the gel or not,' says Chem Prof.

'We would need a motor to pump the water upwards first and the motor would be needed to be covered with a hood to prevent water from short circuiting the motor,' says Elec Prof.

'Turn the pipes upwards and then u-turned back towards the bucket,' says Mech Prof

'I suggest the use of a new subermisble motor which would not malfunction with water contact,' says Mech Prof.

'A chassis should be built for the motor to rest on and this could be grouted into the wall using the same quick set resin,' says Civil Prof.

'The motor should be used with Poly propylene impeller blades since the coating in the blades could wear out and expose the corroded MS again,' says Met Prof.

All this is being discussed by Profs punching away on laptops and reading up reams of books, journals and papers.

Finally, the Prof goes home carrying plans and papers that emerged out of this brainstorming session, smiling to himself. 'This is what high quality research does. You come up with high quality solutions.'

At home, 'You look scrubbed and bathed. How did you manage?' 'I just moved the bucket under the tap and bathed'.

MAILING ADDRESS