IIT BOMBAY

update

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The Globalization of Higher Education

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- Tsunami Characterization Studies

Editorial

Higher technical education, which has emerged as one of the most significant components of global strategy, has become the subject of an impassioned debate both within and without the international academia. The future of a nation's economic health appears soundly tied to its ability to invigorate and sustain its technical education system. The path the academia needs to tread today seems replete with unaccustomed challenges. What are the future lineaments of the higher academia? This is the subject that the present issue of our R&D magazine focuses on. As it is true with things in flux, there are more questions than answers in this arena of deliberations. But we hope that, even if in a nascent way, our readers would be sensitized to the prime concerns.

This issue of UPDATE also affords another glimpse of the diversity of our research programs and achievements spanning the material and biological sciences, and engineering. Of special interest are articles on topical themes such as *E-governance*, and *National Information Access Policy*. By way recounting IIT Bombay's ongoing research engagement with it, we also re-visit one of the most damaging natural calamities in recent human history, the Tsunami that left the world shocked last December.

Sandip Roy, Editor

IRCC Notes

The IIT system has traditionally been known for the quality of undergraduate education it imparts. However, over the last decade the IITs have been increasing their research focus and making the transition to becoming quality research institutions. A key element in enhancing research is strengthening the Ph.D programmes and enhancing the quality and quantity of Ph.D output. At most universities around the world it is the work done by the Ph.D students under the guidance of faculty that result in publications, patents, awards. The hallmark of a vibrant research environment is its research scholars (Ph.D and post-doctoral students).

How does India compare in terms of science and engineering doctorates? It is estimated that India produces about 4500 science doctorates and about 400 engineering doctorates annually. In comparison, the US produced about 7000 engineering doctorates and 20,000 science doctorates in 2003, China produces about 8000 engineering and science doctorates. It is interesting to note that during the period 1985-2000, of the US science and engineering doctorates 13,274 were from India (almost 1000 per year of which Engineering and Computer Science accounted for about 7300 or 480 per year).

Most countries have understood that in order to maintain leadership in R & D today they need to increase science & engineering doctoral outputs. In the US 60% of the science and engineering doctorates are graduates from other countries. Germany, UK, Japan and Korea are also trying to attract international students for doctoral studies.

In 1995 Japan launched the 'plan for 10,000 - man support for Post-doctorates' that attempts to provide about 10,000 post-doc opportunities in Japanese research institutions and universities. Over the last few years IIT Bombay has been visited by several delegations from some of the top universities of the world, who are keen on forging linkages with the Institute. One of the prime purposes of such collaborations is to attract some of our brightest talents for their doctoral programmes.

Why are science and engineering doctorates important for India? If India is to be a leader in science and technology, it is essential to have independent thinkers and innovators. Ph.D provides rigorous training on a focused problem where the candidate has to come up with an original contribution. In India we produce about 360,000 engineering graduates in about 2000 engineering colleges and universities every year. There is an acute shortage of quality faculty in these colleges. At IIT Bombay we have taken conscious efforts to enhance our post-graduate output. At present 60% of our output is post-graduates; this is a significant increase over the 1990 numbers when we had less than 50 % post-graduates. In this year's convocation (August, 2005) we expect to award about 110 Doctoral degrees (40 Science, 60 Engineering, 12 Humanities and Management). Our present faculty strength is about 420. Hence the annual Ph.D/faculty ratio is about 0.25. This ratio is probably among the highest for any Indian engineering institution. A target for a good research institution should be above 0.5 Ph.D students graduating per faculty per year (University of Illinois-Urbanna Champaign ~0.4, MIT~0.8, Stanford and Berkeley~0.8-1.0). At present in many of the engineering departments we are not able to fill up the funded Ph.D seats due to a paucity of quality applicants.

What can we do to enhance our Ph.D output? The first motivating factor is to increase salaries that doctorates command. A survey of starting salaries of graduating students in 2004 at the College of Engineering in the University of Illinois Urbana Champaign (USA) revealed that the average monthly salaries for BS graduates was $4146, $5208 for MS graduates and $6245 for PhD graduates (50% above the BS starting salary). At IIT Bombay, of the 128 companies that participated in campus placements, only 10 were interested in recruiting PhDs and finally none of them recruited any PhD student. The starting salaries in most academic and research openings in India are just about equal to the salaries of the graduating B.Tech students (Rs 300,000 per year).

A recent initiative by the CII - Western region and IIT Bombay industry - education committee is building a mechanism to provide suitable jobs for IIT Bombay PhDs in industry. Industry sponsorship of fellowships for Ph.D students can also help attract better students. We have now provided our PhD students the funding to attend international conferences and also encourage them to incubate companies through our newly established Society for Innovation and Entrepreneurship (SINE). A recently launched collaboration with NUS Singapore has started a joint IITB - NUS PhD programme on advanced materials. We need to team up with the industry and government to attract our bright youngsters to pursue PhDs in science and engineering.

Rangan Banerjee, Associate Dean R&D

Major New Consultancy Projects

Investigator	Department	Project Title
S Mahapatra	Electrical Engg	NBTI in PMOS Devices and Reliability of SONOS Flash
P K Sikdar	Civil Engg	Traffic Safety Survey
V R Rao	Electrical Engg	Development of Silicon Drift Detectors with Integrated Low Noise Junction Field Effect Transistors
R N Banavar	Systems & Control Engg	Robust Control Law Development for a Reusable Launch Vehicle
V R Rao	Electrical Engg	Development of XRFET Radiation Dosimeters
G R Shevare	Aerospace Engg	Installation, Testing & Training of IIT Zeus Grid Generator Software
G Sivakumar	Computer Science & Engg	Technical Advisory Committee for IT Projects
K V K Rao	Civil Engg	Investigation of Failure and Design of Cement Concrete Pavement
S K Sane	Aerospace Engg	Development of Thermodynamic Engine Simulation Model
M N Kulkarni	Civil Engg	Land Subsidence Studies in Gujarat using GPS
B K Chakravarthy	Industrial Design Centre	Design and Prototyping of Oval Petrol Pump-Use of Contemporary Tools and Processes
D N Singh	Civil Engg	Advisory Services for Augmentation of Infrastructure at Jawaharlal Nehru Port
N L Sarda	Computer Science & Engg	Advise on Core Banking Solution
P P Wangikar	Chemical Engg	Process Development for New Molecules
S C Patwardhan	Chemical Engg	Wireless Control of Distillation Column
T Kundu	Physics	Laser Show Equipments
A S Khanna	Corrosion Science & Engg	Steel Testing for Mechanical, Chemical and Corrosion Resistance
S B Patkar	Mathematics	Algorithmic Solutions for Automation of VLSI Physical Design
G Kumar	Electrical Engg	Microwave Components, Equipment and Software
M V Rane	Mechanical Engg	Heat Recovery Unit for Stenter Exhaust
M V Rane	Mechanical Engg	Preservation of Holy Ice Lingam at Shri Amarnathji Cave

Major New Sponsored Projects

Investigator	Department	Project Title
V R Rao	Electrical Engg	Novel Device Structures for Sub 65 nm Node CMOS Technologies
P M Mujumdar	Aerospace Engg	Centre of Excellence for Aerospace Systems Design and Engineering
D Panda	School of Biosciences & Bioengg	Polymerisation Dynamics of Bacterial Cell Division Proteins FTSZ and Mammalian Cell Division Proteins Microtubules - Functional and Therapeutic Implications
S Noronha	Chemical Engg	Enhancement of Biotransformations
K V Venkatesh	Chemical Engg	Elucidation of Design Principles in Biological Systems through in Silico Analysis: A Path towards Drug Discovery & Reverse Engineering
D K Sharma	Electrical Engg	VLSI Design Laboratory
D B Phatak	KReSIT	Enhancing Integrated Logistics Management System (ILMS)
P Ghosh	Chemistry	Studies of N-Heterocyclic Carbene Complexes of Nickel and Palladium as Potential Catalysts for Olefin Polymerization with Functional Monomers

Select MOUs

Organization	Date Signed	Scope
Institut de Technologie du Cambodge (ITC), Cambodia	November 2004	To Promote Cooperation in Education and Research and Development Activities
Purdue University, USA	December 2004	To Establish a Leading Comprehensive Strategic Partnership in Engineering
Indo Swiss Academic Alliance	September 2004	Joint Initiative of Indian and Swiss Governments to Enhance and Support Mutual Cross Cultural Awareness in Higher Education in Science and Technology in both Countries
Nanyang Technological University, Singapore	January 2005	To Promote Cooperation in Education and Research and Development Activities
National University of Singapore (NUS)	March 2005	To Establish a Joint Degree Programme at the Masters and Doctoral Levels
National Institute of Oceanography Goa	April 2005	Long Term Collaboration in Research, Teaching and Training

Awards

Prof J M Vasi, Deptt of Electrical Engineering has been elected as an IEEE Fellow.

Prof N K Naik, Deptt of Aerospace Engineering has been elected as Fellow of the Indian National Academy of Engineering and Fellow of the National Academy of Sciences, India.

Prof D P Nandedkar, Deptt of Electrical Engineering has been elected as a Fellow of IETE, India.

Prof G Mathew, Deptt of Earth Sciences, has been awarded BOYSCAST Fellowship to conduct research at the Mars Flight Mission Facility, Department of Geological Sciences, Arizona State University, USA.

Prof K Trivedi, IDC, has received the Silver Award for Excellence in Innovation at the India International Trade Fair 2004, at New Delhi for his design on K-Yan - the Compact Media Centre.

Prof S Sarawagi, KReSIT, is a recipient of the IBM Faculty Award 2004, in recognition of the quality of her research and its importance to industry.

Prof D Choudhury, Deptt of Civil Engineering has received the ISCA Young Scientist Award for the year 2004-2005 from the Indian Science Congress Association (ISCA), Govt of India.

Prof G K Lahiri, Deptt of Chemistry has been elected as a Fellow of the Indian Academy of Sciences.

Prof S Chaudhuri, Deptt of Electrical Engineering has been elected as Fellow of the Indian Academy of Sciences.

Prof S Dutta Roy, Deptt of Electrical Engineering has been selected for the BOYSCAST Fellowship for the year 2004-2005.

Dr N G Shah, CTARA and Prof K V Venkatesh, Deptt of Chemical Engineering have received a joint award from Indian Institute of Chemical Engineers, constituted by Hindustan Dorr-Oliver for excellence in use of Science and Technology in Rural Development.

Prof K G Narayankhedkar, Deptt of Mechanical Engineering has received the first Prof A Bose Memorial Life Time Contribution Award in Cryogenics for his significant research contribution in the area of Cryogenics.

Prof S C Sahasrabudhe, (Retd) Deptt of Electrical Engineering was presented with the Lifetime Achievement Award by IIT Bombay, in recognition of his contribution as a teacher and researcher engineer.

Lifetime Achievement Award

Prof S C Sahasrabudhe, former Dy. Director of the Institute and retired faculty from the Electrical Engineering Department, was presented with the Lifetime Achievement Award in recognition of his contribution as a great teacher and researcher-engineer in the country. He has been associated with Electrical Engineering Department, IIT Bombay since 1971. Apart from being a Professor in the department, he has been its Head from 1980 to 1983. He was also Head of the Advanced Center for Research in

Electronics (ACRE). His phenomenal work in the field of Communications, Signals and Image Processing and Microprocessor Applications has won him various prestigious awards such as S K Mitra Memorial Award (IETE) 1981 and S V C Ajay Memorial Award for Outstanding Contribution in Motivating Research Work in Electronics and Telecommunication Engineering, 1998. Currently he is Director, Dhirubhai Ambani Institute of Information and Communication Technology.

Awards for Excellence in Research and Teaching instituted by IITB Alumni

Awards for Excellence in Research and Teaching instituted by Alumni were given to a number of faculty on the occasion of the Foundation Day of IIT Bombay. The awardees include

Faculty	Awards
❑ Prof P Mathur (Chemistry)	Prof S C Bhattacharya Award for Pure Sciences. Cash Award of Rs 1.5 Lakh
❑ Prof U V Shenoy (Chemical Engg)	Indira Manudhane Best Undergraduate Teacher Award 2004 in Chemical Engg
❑ Prof P P Wangikar (Chemical Engg)	R G Manudhane Faculty Research Excellence Award 2004 in Chemical Engg
❑ Prof A Mehra, & Prof S C Patwardhan (Chemical Engg)	Indira Manudhane Applied Research Project Awards 2004 in Chemical Engg
❑ Prof D V Khakhar (Chemical Engg)	Prof H H Mathur Award in Applied Sciences, Cash Award of Rs 1.5 Lakh

FAN-IIT Bombay Workshop on Nanotechnology

The Faculty-Alumni-Network (FAN) and IIT Bombay jointly organized an International Workshop on Nanotechnology at IIT Bombay during January 6-8, 2005. The workshop had 21 high quality presentations from invited researchers from USA, Australia, Singapore and by IITB faculty. Over 160 participants attended this workshop. The oral presentations along with poster presentations at this workshop highlighting the research activities by IIT Bombay researchers were in the broad areas of Nanomaterials, Nanobiotechnology, and Nanoelectronics. The purpose of the workshop was to mainly identify specific areas where increased collaboration is possible between the FAN members and the IITB faculty.

One of the major highlights of the workshop was a session on "Mumbai Initiative on Nanotechnology" chaired by Dr R Chidambaram, Principal Scientific Adviser to the Govt of India with an inaugural address by him, followed by presentations by the directors of BARC, TIFR and IIT Bombay. In his address Dr Chidambaram highlighted the importance of Nanotechnology research for India, and how India can make a mark in this emerging field. He also highlighted the various national level initiatives for strengthening research in the area of Nanotechnology and the steps proposed in this direction. He specifically mentioned the recent initiatives by the Govt of India in setting up two Centres of Excellence for research in Nanoelectronics, with one of the centres being located at IIT Bombay. He also requested the FAN members to share their experiences with similar initiatives they have been involved in other countries, to shape up the national level programmes. At the end of the session, a "Charter for the Mumbai Nanotechnology Initiative" was signed by the three directors who expressed their willingness for strengthening their collaboration in the area of Nanotechnology.

Inauguration of the Technology Business Incubator at IIT Bombay

The Technology Business Incubator (TBI) established at IIT Bombay by Society for Innovation and Entrepreneurship (SINE), IIT Bombay, was inaugurated by Dr V S Ramamurthy, Secretary, Department of Science and Technology, Govt of India on April 28, 2005. Shri Rahul Bajaj, Chairman, Board of Governors, IIT Bombay and Chairman, Bajaj Auto Ltd. was also present on the occasion.

Dr V S Ramamurthy termed this an important milestone in the development of entrepreneurship in the country. IIT Bombay has advantages conducive to entrepreneurship including top class students, faculty, and a range of disciplines. The Business Incubator at IIT Bombay could become a model for academia to emulate, he said.

Shri Rahul Bajaj while speaking on the occasion said that activities such as SINE should be encouraged and promoted as entrepreneurship is the root of the economic development of the country.

Prof Ashok Misra, Director, IIT Bombay said that the incubator would be a boon to the IIT community and new companies. He mentioned the future vision of IIT to start a Technology Park in the vicinity, which will draw on the advantages available at IIT Bombay and the advanced technology companies nearby.

Prof N L Sarda, Professor In-charge SINE, said that SINE will endeavour to provide enabling conditions that create successful entrepreneurship through the use of knowledge and innovation. He also mentioned about Rs 2 crores (approx.) support provided by Department of Science and Technology, Govt of India, as an initial grant for this initiative.

SINE has grown out of the IIT - Industry interaction of the R&D section of IIT Bombay. Prof K C Khilar, Dean R&D, speaking at the function said that the R&D journey at the institute used to stop at publication and patents stage. Business Incubator will take the journey further and will help end product of research reach the society. It will also give a boost to good research work.

Spread over 10000 sq.ft. the incubator will provide full support to the Incubatee Companies including physical infrastructure such as fully furnished offices with computers, internet connectivity, meeting rooms, conference rooms, and other shared facilities. Apart from these, the incubator will also facilitate networking and mentoring support, organise showcasing events for incubatee companies and conduct training programmes which are relevant for the entrepreneurs. Additional support will also be provided by a resource centre sponsored by the National Entrepreneurship Network (NEN). The Incubator will focus primarily on Technology based companies set up by IIT Bombay community for business incubation and will also admit technology based companies with strategic and social values.

Advanced Planning and Scheduling Solutions for Pulp, Paper and Printing Industries

Sachin C Patwardhan, Department of Chemical Engineering

This work presents a novel approach for enterprise-wide planning and scheduling problem in paper, pulp and printing industry. This is essentially a large dimensional *mixed integer nonlinear optimization* problem. In the current approach it has been systematically decomposed into the interconnected smaller sub-problems by using spatial and temporal considerations. Each of these sub-problems can be solved relatively easily and with less computational efforts using existing capabilities of the available solvers and personal computers.

The proposed decomposition has a hierarchical structure, which strongly relies on the algorithmic approach with minimal use of heuristics and permits systematic analysis of the problem at various levels. The *rolling horizon* concept is used to deal with the dimensionality problem along with the changing future demands and possible disruptions. The resulting set of large scale sub-problems are solved using ILOG CPLEX 7.1 Solver. The efficacy of the proposed solution approach is evaluated by conducting studies on a large dimensional industrial problem (3200 orders, 5 paper machines and 3 month horizon, about 300,000 variables). The proposed solution scheme provides satisfactory solutions to the large scale industrial problem for multiple scenarios in a reasonable time frame (about 2 to 3 minutes on 2.4 GHz PIV PC). Thus, the proposed solution scheme can effectively deal with large dimensional enterprise-wise order allocation, inventory allocation, run formation, trimming and pattern sequencing problems in a coordinated fashion.

This project was funded by Honeywell Technology Solution Laboratory. (HTSL), Bangalore and IIT Bombay team working on the project consisted of Prof Sachin Patwardhan (PI), Prof K P Madhavan (Consultant), Mangesh Kapadi and S A Munawar (project engineers). Also, HTSL, Bangalore and IIT Bombay are in the process of jointly filing two US patents based on the technology developed.

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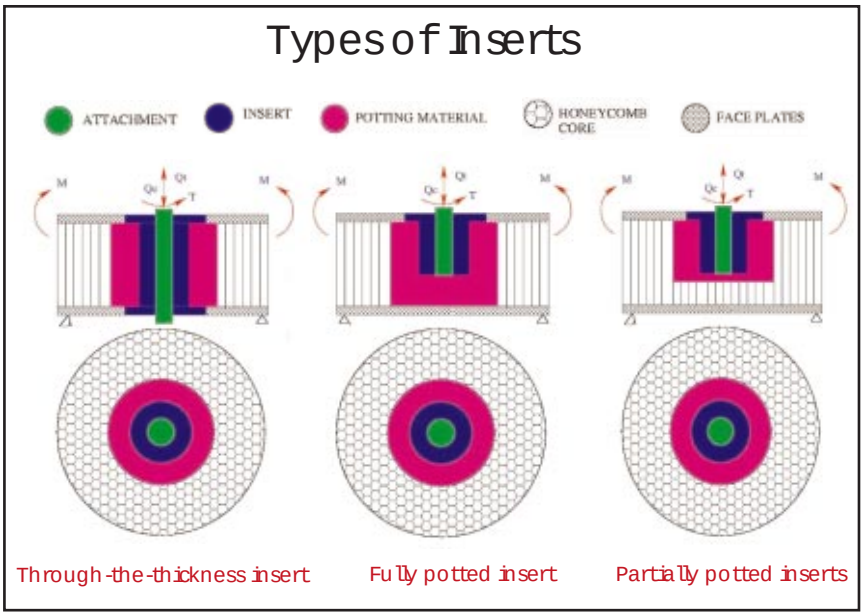
Development of Sandwich Structures with "through-the-thickness" Composite Inserts

N K Naik, Department of Aerospace Engineering

'Sandwich' structures are widely used in the aerospace industry where weight is an important consideration. The basic purpose of a sandwich construction is to produce a stiff, strong and light weight structure. This can be achieved by combining a low density core with high stiffness and high strength face-plates. A sandwich structure is made of thick honeycomb / foam light weight core material and high strength aluminum / polymer matrix composite face-plates. The face-plates and core of the sandwich structure are bonded together with adhesive film.



Generally, the core materials have lower density, in-plane elastic modulus and in-plane shear modulus. However, the face-plates have higher values of stiffness and strength. The face-plates carry bending load whereas the core carries shear load. The elastic modulus of the face-plates is two to three orders more than the elastic modulus of the core material. For high performance applications, usually the honeycomb structure forms the core as they have higher values of strength-to-density ratio.

However, such structures are not strong enough to withstand the localized external loads as the in-plane normal and shear strengths of the honeycomb core materials are very low. If such structures need to absorb localized external loads, it is necessary to adopt special means in order to prevent the occurrence of premature failures induced by the local bending effects. One way of reducing such bending effects is the use of *inserts*.

Features of Inserts

The insert is part of a detachable fixation device. It permits the interconnection of honeycomb sandwich structures, the connection between them and other structural parts (frames, brackets), and the mounting of equipment (boxes, feed lines, cable ducts, etc.). The system consists of a removable and a fixed structural element. The removable part is either a screw or other element threaded to a nut-like part, the insert. This is connected to the honeycomb-structure which is a fixed ele-

ment by means of an epoxy compound.

Inserts allow sub-assemblies to be attached to sandwich structures. In such a case they transmit loads *to* and *from* the structure. Inserts also provide excellent resistance to shear, tensile, compressive and torque loads. Therefore, they improve the mechanical behavior of the honeycomb sandwich structures by reducing the occurrence of severe local bending effects induced by the localized external loads.

Inserts are widely used in space vehicles and satellite solar panels. They connect the solar panels of the satellite to the main structure of the satellite. They are also used in civil applications like automobile chassis construction and in marine applications. In practice, the inserts are made of isotropic materials (metals). Although such metallic inserts possess good strength and stiffness, they have higher densities.

"Through-the-thickness" inserts: R&D at IIT Bombay

For the effective utilization of sandwich structures with inserts, the specific strength of the insert assembly should be as high as possible. One way to satisfy this requirement is to use polymer matrix composite materials as inserts (instead of metallic ones). This is because the composite materials have higher *specific* strength and stiffness. One of the desired properties of inserts is enhanced *through-the-thickness* stiffness and strength, which can be achieved using 3D *orthotropic* polymer matrix composites. This improves the performance of honeycomb sandwich structures. Configurations of typical 3D woven composite insert assemblies analyzed are presented in the illustration.

Design and development of an array of 3D *woven composite insert assemblies* with special geometrical and material characteristics for honeycomb sandwich structures have been carried out at IIT Bombay. The principal researchers are Prof N K Naik and Mr G Nageswara Rao of Aerospace Engineering Department. The inserts designed by the team have been patented and are being considered for a variety of high-end applications.

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Old Molecule, New Roles: Neurotransmission by ATP

Para Ghildyal, D Palani & Rohit Manchanda, School of Biosciences & Bioengineering

Adenosine 5'-triphosphate (ATP) has long been known to be responsible for the storage and provision of metabolic energy in biological organisms. However, in the past few decades an unexpected extra-cellular function of ATP has emerged. For long, it had been postulated that ATP is released from nerves and it acts upon target cells in order to transmit signals across synapses (the space between nerve cells and target cells), i.e. as a synaptic neurotransmitter. In mediating this function, ATP joined the ranks of neurotransmitter molecules such as: the better-known acetylcholine (ACh), noradrenaline (NA), serotonin (5-HT), dopamine (DA), and gamma-amino butyric acid (GABA). It was in the late sixties and early seventies, with the discovery and elucidation of "purinergic" nerves, that the possible role of ATP as a neurotransmitter was propounded.

Over the ensuing three decades, neurotransmitter functions of ATP have been the subject of intensive scientific scrutiny. It has been shown to act via specialized membrane proteins called the purinergic receptors. These receptors are of two types – the P_{2X} which are the fast acting ligand-gated receptors and the P_{2Y} which are slower acting G-protein linked metabotropic receptors. ATP thus transmits signals carried by the nerves via the P_{2X} receptors in a few milliseconds (fast neurotransmission), and by the P_{2Y} receptors over a few hundreds of milliseconds to seconds (slow neurotransmission) in a variety of systems in the brain, spinal cord and other peripheral organs.

Studies on the neurotransmitter function of ATP led to the discovery of an even more interesting phenomenon. Individual neurons of the autonomic nervous system were found to contain and release ATP along with a classical neurotransmitter like ACh and NA, thus giving rise to the concept of "Co-transmission". Co-transmission has been described as the co-localization and co-release of two or more neurotransmitters upon nerve stimulation from the same nerve terminals, to act on the post-synaptic cells to carry out the process of neurotransmission. The actions of co-transmitters on the post-synaptic cells have been reported to be either synergistic or antagonistic. Indeed, studies on purinergic co-transmission in the CNS have given rise to interesting insights on how transmitters might interact to produce novel patterns of post-synaptic activation, unobtainable by either transmitter alone.

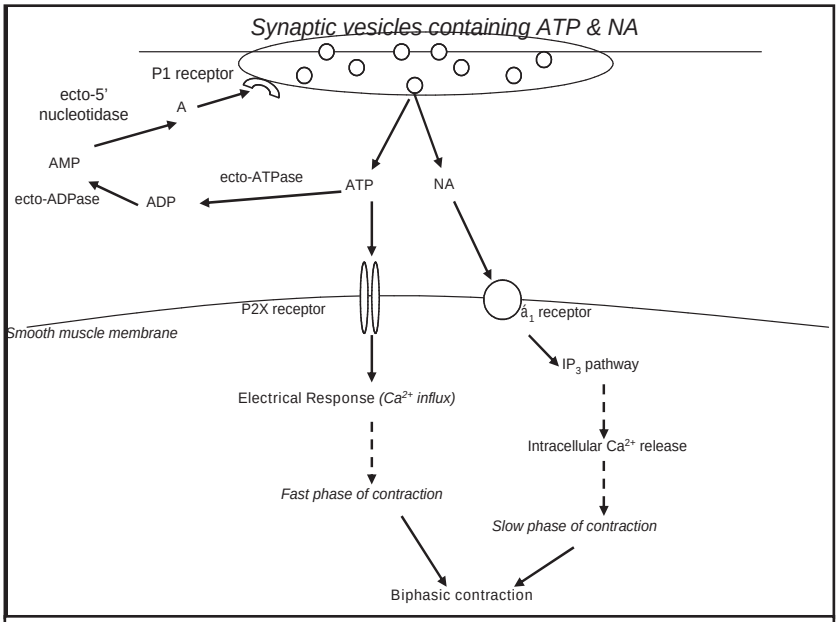
Research at IIT Bombay

This novel feature of co-transmission by ATP along with other neurotransmitters alters our concept of the biophysics and biochemistry of neurotransmission at these synapses. In the nerve-muscle physiology laboratory of the *School of Biosciences & Bioengineering*, we are investigating various aspects of both these issues, i.e. the involvement of ATP as a synaptic neurotransmitter and its significance in co-transmission.

For any molecule to be classified as a neurotransmitter there are certain criteria that need to be fulfilled. For example, for every neurotransmitter, its synthesis and storage in the nerve terminals have to be demonstrated. Further, it should be shown that the proposed neurotransmitter is released from the nerve terminal on nerve stimulation. External application of a neurotransmitter should mimic the response to nerve stimulation, and finally, an effective system for the inactivation of the neurotransmitter molecule from the synapse should be present.

Inactivation: significance and investigation

Neurotransmitter inactivation is of a vital importance since the rate of neurotransmitter degradation often determines time periods of the electrical signals generated by it. Swift and efficient removal systems in the form of enzyme inactivation or re-uptake mechanisms for a neurotransmitter form an



Sympathetic Excitatory Co-transmission by NA and ATP in the Mammalian Vas Deferens

integral part of the process of neurotransmission. Studies conducted in our laboratory work are directed towards understanding the mechanism of inactivation of ATP after its release into the synaptic cleft.

The model system that we use is a smooth (involuntary) muscle organ of the male reproductive system, the mammalian *vas deferens*, where ATP and NA are known to act as co-transmitters. The accompanying illustration is a schematic representation of co-transmission in this model system, with special attention to the synaptic inactivation mechanisms known to be present for ATP. Using a specific inhibitor of the synaptic ATPase, we have characterized the activity of the enzyme involved in ATP hydrolysis in the synaptic cleft.

We have also investigated the role of the ATPase in purinergic signaling using electrophysiological techniques like intracellular recordings of synaptic potentials. Using fine glass microelectrodes it is possible to measure the potential changes occurring in individual live cells of the tissue. Such intracellular recordings have shown that inhibition of the ATP hydrolyzing enzyme (called an ecto-ATPase) results in an increase in the concentration and life time of synaptic ATP and therefore results in significantly enhanced electrical signaling by ATP. The electrical signaling by ATP results in a physiological response of the vas deferens tissue in the form of a contraction. Enhanced electrical signals are therefore translated into enhanced contractions of the tissue.

Using force transducers that measure the force generated by the contracting vas deferens we have also been able to show that inhibition of the ATP degrading enzyme results in greater and more prolonged contractions in the vas deferens. These studies on the effects of enzyme inhibition on tissue responses underline the role of an efficient neurotransmitter inactivation system at synapses which helps in fine tuning/controlling the physiological responses of a tissue and without which these responses would be exaggerated and prolonged.

Co-transmission: recent findings

An interesting aspect of co-transmission is the way some smooth muscles respond mechanically to nerve stimulation. Due to the presence of two neurotransmitters many smooth muscles respond with *biphasic* contractions, with each phase being mediated by one of the co-transmitters. In organs where ATP and NA act as co-transmitters, ATP generally acts as a fast, and NA as a slow transmitter. Consequently, the contractions of these organs have a fast phase mediated by ATP and a slower phase mediated by NA. By using specific pharmacological blockers of ATP or NA action, it is therefore possible to selectively "dissect out" one phase from the other (e.g. in the vas deferens of the guinea pig). However, we find that in certain organs, such as the vas deferens of the rat, the picture may be more complicated. Here, both ATP and NA may contribute as significantly to the slower second phase of the contraction as to the first rapid phase. In such a scenario, it is clearly not possible to separate the two phases pharmacologically. Furthermore we find that, as opposed to the synergy between co-transmitters suggested in many other systems, in this tissue there is no evidence of synergy between ATP and NA in either of the phases. Thus there may be no universal model of co-transmission applicable to all synapses or organs and synapse- or organ-specific schemes could exist which would need to be elaborated individually.

Beyond Physiology

As described above, purinergic neurotransmission has been implicated in the functioning of both the peripheral and the central nervous systems. The question inevitably arises as to whether these physiological findings might lead to applications in the understanding and amelioration of certain disorders. In recent years, a number of studies have suggested that this extension might indeed be possible. For example, an especially interesting role for ATP and related purines to emerge is that in transduction of painful stimulus by nociceptive terminals and modulation of the afferent pain signals at spinal synapses involve multiple types of purinergic receptors. In vivo studies on animals and humans have shown that administration of ATP and adenosine at low concentrations may lower the requirement for post-operative opioid administration for pain relief via a "pain gating" mechanism. In the vas deferens, the role of the purinergic transmission in contractility has been unequivocally demonstrated, and there is strong evidence that ATP contributes significantly to bladder contraction. These findings strongly suggest that issues concerning male fertility and incontinence could be approached using drugs that target purinergic (as opposed to noradrenergic) mechanisms, and it is expected that therapeutic applications would be evolved in the near future.

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Recovering Aircraft Safety after Loss of Pilot Control: An Innovative Algorithm

N Ananthkrishnan, Department of Aerospace Engineering

Over the recent years we have witnessed frequent media reports on crashes of military aircrafts in our country. Such incidents do keep recurring globally in peacetime. Crashes could be due to various causes: bird hits, mechanical defects, bad weather, etc. However, recent statistics have shown that a large number of crashes are due to a specific problem faced by pilots called spatial disorientation (SD).

When flying difficult sorties and under poor weather conditions, pilots can be confused (disoriented) about which way they are heading (up or down), and whether the ground is below their feet or above their head! For example, military pilots are known to suffer from visual illusions during night flying such as mistaking discrete ground lights for the stars and consequently flying inverted (upside down).

A recent study has shown that almost 90-100% of aircrew have reported at least one incidence of SD during their flying career. Pilots either fail to recognize an SD condition and hence take no corrective action or, even when they recognize the problem, are too disoriented to be able to recover the aircraft to safe flight. In most cases, the aircraft ends up in what is called a spin or a spiral dive with the pilot having no control of the aircraft – the airplane nose drops, it starts going around in circles while losing height rapidly.

Spatial disorientation is a problem that can confront any pilot, no matter how highly experienced and well trained. During the years 1980-89, the US Navy reported 112 major accidents, and the US Air Force reported 270 major accidents, involving SD and loss of pilot control. Pilots of general aviation (light) aircraft are equally vulnerable to SD - one of the more high profile crashes was that of the Piper Saratoga being flown by John F Kennedy, Jr. on July 16, 1999. Unfortunately, many accidents caused by spatial disorientation are wrongly labeled as due to pilot error.

To avoid loss of costly airplanes and to save precious human lives, a two-pronged strategy has been suggested in the literature:

- Pilots should be trained in flight simulators to recognize SD situations and hit a Panic Button provided in the cock pit
- The aircraft's automatic flight control system should have a Panic Button Algorithm that takes control of the air plane from the pilot and recovers the airplane to a normal flying condition.

However, developing an effective Panic Button Algorithm has been a challenge because of the tight constraints involved: pilots will usually hit the button only when they are in a hopeless situation with the plane already hurtling to the ground, and the algorithm must respond in a very short time before an imminent crash.

The New Algorithm

In a major breakthrough, researchers at the Department of Aerospace Engineering, IIT Bombay, working over the last 3 years (2002-04), have come up with a novel Panic Button Algorithm that seems to meet the challenges pointed out above. The research team consisted of students (P K Raghavendra and Tuhin Sahai, P Ashwani Kumar), a research assistant (Manan Chauhan), and the author. The work was partly funded by the Aeronautical Development Agency (ADA), Bangalore.

F 18 Airplane (Courtesy: NASA Drygen Flight Research Centre)

Using a combination of two sophisticated new methods called *Nonlinear Dynamic Inversion* (NDI) and *Extended Bifurcation Analysis* (EBA), the team from IIT Bombay has devised a unique *Panic Button Algorithm* that successfully recovers an airplane from even the most adverse flight conditions. The crux of the present work lies in recognizing that a successful algorithm must use a two-step approach where it is necessary for the airplane to pass through an intermediate (waypoint) state before it can be properly recovered to a safe flight condition.

The research team has carried out extensive computer simulations using high-fidelity aerodata obtained from NASA for a specially modified F-18 airplane called the High Angle-of-Attack Research Vehicle HARV (see illustration) to establish the effectiveness of their algorithm. In the future, the Panic Button Algorithm could be built into sophisticated Flight Control Systems being developed for advanced combat aircraft such as 'Tejas' the Indian Light Combat Aircraft (LCA). Interestingly, their work also shows that aircraft equipped with thrust vectoring (TV) engines, such as the Sukhoi SU-30, have a 60 per cent better chance at successful recovery as compared to aircraft without TV capability. Translated in terms of height from the ground, airplanes with TV can be recovered after loss of control at much lower altitudes, which is important since nearly 100 per cent of loss of control cases at low altitudes presently end up as crashes.

Presented at the Aerospace Sciences Meeting organized by the American Institute of Aeronautics and Astronautics (AIAA) at Reno, NV, USA (Jan 2004), the work has been appreciated internationally for its thoroughness and novelty. It is expected to be of high value to the international aircraft design community.

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The Promise of E-governance

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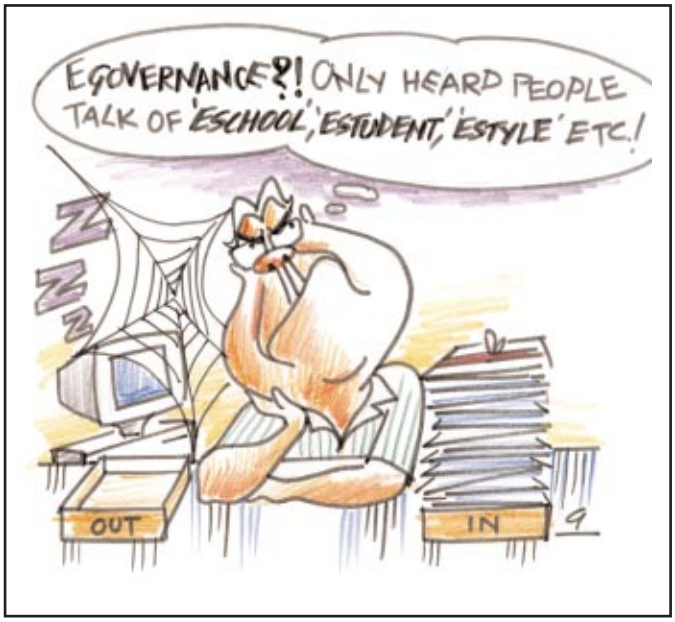
In recent times, governments, NGOs, the corporate sector and academia, all have come to recognize *E-Governance* as a potential driver as well as enabler to reinvent government and public administration, that it can help deal with development problems efficiently, and deliver services to citizens in a more responsive and responsible manner.

E-governance – sometimes also referred to as *Digital Governance* – refers to governance processes in which Information and Communications Technology (ICT) play a significant role. ICTs can improve the delivery and standards of governance services, as well as enhance the participation of people in governance. Since most government agencies tend to withhold information from citizens – which can be a means to maintain and extend undue control over society – E-governance is perceived as one of the principal mechanisms of empowering citizens through greater access to information regarding government plans, programmes and policies, as well as their implementation. In addition, E-governance has the capability of enabling citizens to exercise greater influence on public decision-making by providing timely access to *quality* information. Rather than remain passive recipients of services provided to them, citizens gain the ability to participate in, and influence decision-making processes which affect their lives.



The Role of ICTs

In general, ICTs play a role in transforming the traditional functioning of government into E-governance practices in three ways:

- Automation of repetitive tasks, thereby improving efficiency of government processes – eg. birth and death registration, obtaining licenses and permits, etc.
- Supplementing existing efforts and processes to improve governance by using the Internet for providing greater transparency in government functioning.
- Providing new government services or mechanisms for better service delivery which was earlier impossible through non-ICT modes eg., ability to access and bring together information from different sources, faster disposal of applications, reducing paper work etc.

In practice however, especially in India, E-governance has simply meant digitalization, or automation of governance services. It has mainly involved provision of basic services and information, rather than work as a two – way tool involving public feedback for improved government decision-making. 'Governance' as differentiated from 'government' is often used to mean a more participatory approach to development and service delivery as opposed to a top down, bureaucratic approach. However, the governance aspect is rarely to be found in most of the E-governance projects in India, which are merely glorified clusters of information kiosks. If governance is a political process dealing with reform of government functioning towards "good governance", governance reform requires attitudinal and constitutional changes, which cannot be brought about merely through digitalization and infusion of ICTs.

Beyond Digitalization

Undoubtedly, E-governance can revolutionize the reform process towards better and more participatory and inclusive governance; but this requires political will, and qualitative changes in the governance process. For this the question of access to ICTs is an important issue, as is the design of E-governance projects. Unfortunately, to date such ventures have been mostly unimaginative ones, carried out by technocrats and bureaucrats with little or no consideration for insights provided by the social sciences regarding prevalent social structures, power equations, and economic systems.

Among implementing agencies of E-governance projects, there is often a confusion regarding areas where it can be applied. In the context of privatization of services earlier provided by the government, and in view of the purportedly more inclusive concept of governance that has come to replace government, it no longer makes sense to restrict E-governance only to public sector agencies. However several activists and scholars working in the field refrain from extending E-governance to the private sector even where it has taken over provision of basic services to citizens from the government.

But more importantly, anywhere in the country, E-governance has rarely led to public participation in decision making. Projects have mostly tried to make efficient delivery of repetitive and routine government tasks such as the issue of forms, permits, registrations, licenses etc. While this marks an important change towards efficiency of government functioning, in the context of persistent poverty and inequality, and the continuing significance of the role of government in economic development, E-governance can have an impact only if it goes beyond routine services and focuses on participatory development, increased public role in policy and decision making, and holding governments and private actors to

greater accountability. This requires that greater freedom and autonomy is given to civil society organizations, citizens groups, activists, social movements and individuals to shape the design of E-governance projects.

Much of ICT for governance projects are marked by a tendency to regard ordinary citizens as ignorant people, not technologically savvy, and who need experts to design programmes for them. This betrays an insensitivity which often leads to improper design and wastage of public money. Successful E-governance requires a greater trust in the *ability* of people to transform their lives and should aim to provide them with the opportunities, resources and technologies to do so, rather than impose ill-conceived and inappropriate programmes upon the users. In other words E-governance should evolve from below rather than be designed by bureaucrats and IT firms who are not necessarily best placed to design suitable solutions.

Widening the reach

There is a real danger that E-governance may end up as being beneficial only to the urban middle classes and the corporate sector, while largely bypassing the interests and needs of the vast number of urban and rural poor and other marginalized groups. From our analysis of various E-governance projects it is evident that there is a lot of overblown propaganda about these undertakings, with little of the intended impacts in evidence. This is because most such projects have little understanding of the lack of access to rights, resources, information, technologies and markets that most poor people suffer from.

Technologically formatted information by itself is of little use in the absence of other kinds of changes in society and economy. Projects such as *Gyandoot* in Madhya Pradesh, *Bhoomi* in Karnataka, *E-Seva* in Maharashtra, and *Akshaya* in Kerala are an important step in improving the government/citizen interface. However these projects have not had real impacts on the most-needy of the rural and urban poor, and their initial success has not translated into wider benefits for society at large. Perhaps the high publicity surrounding such projects has masked their essential limitations. On the other hand, projects such as the *Warana Wired Village*, though started with initial support from the government, is now an independent, co-operative and people – driven project. It has had greater success in the use of ICT for bringing about social transformation in terms of increased incomes, reduced corruption, and greater transparency and accountability of economic agents. Similar to other technology driven projects, it is high time that E-governance projects relied on scientifically carried out *ex-ante* social impact assessment studies in improving project design and implementation.

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Organizational Leadership: Learning from the Leaders

Atanu Ghosh, Shailesh J Mehta School of Management

Leadership is a complex process by which a person influences others to accomplish a mission, task, or objective and directs the organization in a way that makes it more cohesive and coherent. A person carries out this process by applying his leadership attributes which encompass belief, values, ethics, character, knowledge, and skills. Although the position of a manager, executive or supervisor, provides the authority to accomplish certain tasks and objectives in the organization, this *power* does not make someone a leader...it simply makes him/her the boss. True leadership makes people want to achieve high goals and objectives, while, on the other hand, bosses tell people to accomplish a task or objective.

It may be said that good leaders are *made*; not born. Anybody can become an effective leader provided he has the desire and willpower to become one. Good leaders develop through a never-ending process of self-study, education, training, and experience, and some people do possess these qualities innately.

As part of a course on Leadership & Vision, the SJMSOM hosts *Leadership Lecture Series* during January-February every year. The lectures offer a valuable opportunity to learn about this most complex subject of "Leadership" from many of the eminent personalities and leaders, who are invited to deliver talks. On this platform, many of the speakers have shared their experience of transforming their own organization and reshaping them to withstand the challenges of today's complex business and social environment.

There is little doubt that *vision* plays a pivotal role in organizational performance. In his recent talk under the *Leadership Lecture Series 2005* at the Shailesh J Mehta School of Management (SJMSOM) Dr J J Irani made a telling point: that the act of creating a vision should not just be a top management exercise. Every individual in the company should understand and be an integral part of the organization's vision. Only then the organization can work towards achieving it. Speaking figuratively, he pointed out that in an unmagnetized iron rod the atoms are all oriented randomly. When a current is passed through a coil around it, the atoms are magnetized and align in a single direction. Likewise a true leader should have the ability to align the thoughts of followers in a concerted manner.

Dr J J Irani also elaborated on what he termed the '12 commandments', which he had prescribed for himself when he took over as the Managing Director of M/s Tata Steel. Speaking on the challenge of effecting transformations, he compared an organization in crisis to a patient in ICU. If the organization wished to overcome the crisis, it should be prepared to go through very painful process of 'major surgeries and blood transfusion', in order to emerge out of ICU in health! Although metaphorical, the example underscores the simple truth that the process of organizational recovery cannot be a 'painless' one, and that it needed to be appreciated pragmatically.

This year, SJMSOM also invited Sri Sri Ravishankarji, whose message proved to be very simple, and yet extremely pertinent: that Leadership works through *examples*. As he pointed out, the best form of communication for a leader was to *live* by example – to be totally open, sincere and inclusive. One needs to nurture a sense of belongingness and of responsibility, be able to convey through one's presence, and above all cultivate *non-verbal* communication skills. Leaders must achieve timely communication and try to make it a two-way process by evoking a reciprocal response.

Several other speakers invited for the *Leadership Lecture Series 2005* while recounting their personal experiences, offered valuable insights on how effective leadership can work. Mrs Ranjana Kumar, Chairperson of NABARD, related the challenges specific to leading a PSU. Under her leadership the bank which suffered losses for eight successive years transformed into a healthy, profitable organization. Likewise, Mrs Lalita Gupte expounded on how a development financial institution was transformed to a Universal Bank by learning about retail banking and market entry to number of overseas destinations.

Mr Harsh Mariwalla, Chairman, MARICO Industries, narrated the story of another kind of transformation i.e. making over Marico from a closely held family managed firm to a highly professionally managed organization. He emphasized on the need for Innovation/Incubation, IT deployment, maintaining growth and market leadership, cost management and internationalization, in the context of present scenario in the FMCG sector.

Mr Baba Kalyani's (Chairman, Bharat Forge Ltd) presentation proved to be yet another inspiring account, as he described the process of converting a small auto ancillary manufacturing company to a truly global leader. The key ingredients to the success lay in having a well-stated *strategic* intent, acquisition of firms and successfully merging it in developed countries like Germany, as a result of which Bharat Forge emerged as the most competitive forging company in the world.

Referring to some of his own lifetime experiences, Dr Vijay Mallya, Chairman, UB Group offered stirring, simple and encouraging homilies on leadership. As he pointed out, the key strengths of a leader lay in self-belief and confidence, and a passion that "one can do it". Dr Swati Piramal, Director -Strategy, Nicholas Piramal, adopted a most innovative and subtle way of relating the essence of leadership – through story, music and a high quality video.

Speaking about the challenges confronting the academia today, Prof Ashok Misra, Director, IIT Bombay recounted what was necessary to leading an institute of higher learning like IIT Bombay. His talk captured the changes that higher technical education is undergoing globally.

As one delves deeper into the *foundations* of Leadership, one is faced with the challenge of understanding an entire range of 'inner' human qualities that extend beyond rational intelligence. There is a *uniqueness* associated with the style of leadership displayed by an individual; something which does not seem to follow any standard theory or prescription. The essence of leadership may lie in fostering and giving expression to skills which are popularly described as 'soft', and are more emotive or intuitive in nature.

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Globalization and Higher Technical Education

Ashok Misra, Director

Borrowed from economics, 'Globalization' is a term used to sum up the contemporary world order. Enabled by advances in information technology, the speed of communications has made our world a global village. The convenience of travel has brought people all over the world closer. The compression of barriers of time and space has linked lives of people across the world more intensely and at a faster rate than ever before.

There is now an increased movement of knowledge, ideas, goods and money across natural borders, which in turn has increased interactions between nations in the areas of economics, politics and education. This phenomenon today embraces all sections of the society and its people - their lives, their livelihood, their interactions and really speaking almost all aspects of life in the present era.

Globalization and the Knowledge Economy

Advances is productivity are increasingly based on knowledge

and learning. Since knowledge once disclosed spreads further than capital or people, today's *knowledge economy* is by its very nature global. All countries stand to benefit when new knowledge is internationally shared. It is against this backdrop that higher education is assuming an amplified role and significance than ever before.

Institutions of higher learning where knowledge is transmitted and new knowledge is created forms the true prop of a country's future. The country that has a superior higher education system will have the edge in today's world. Thus, it is a special responsibility of the nation to provide the best education possible both at the high school and the university levels. The focus of such attention must be on *creativity* and *innovation*, especially in the higher education arena. Institutions of higher learning therefore must foster research and provide opportunities to students for developing new ideas.

Transforming Higher Technical Education

In today's world, the Institution or University has to have global standards. Students must be aware of the knowledge that is being transmitted to their counterparts in other parts of the world. Thus the quality of teaching has to be as good as anywhere else in the world. Moreover, students must be able to adjust to jobs anywhere in the world; which implies that cross-cultural aspects should be part of the curriculum. Higher technical education which is the engine for the technological growth of a country needs to transform today so as to be based soundly on all the sciences, emphasize cross-disciplinary areas, and promote interactions with other fields such as economics, business administration, finance, law, entrepreneurship etc.

Challenges in Higher Technical Education

- Attract and retain highest quality faculty
- Inculcate the culture of research, creativity, innovation
- Enhance interactions with the industry
- Develop meaningful collaborations with international institutions
- Attract funding from industry - free up the government from funding to the extent possible
- Address autonomy related issues
- Address fee related issues
- Address responsibility related issues, especially in developing countries

Above all, institutions of higher education must forge a stronger alliance with the industry, the domain of application of the knowledge it generates. In the arena of technology, there can be no better route to enable the genesis of new ideas, patents and generation of intellectual property portfolios. A logical follow up to this is the establishment of technology business incubators, innovation centres and research parks around the institutions. This in turn is expected to attract to campuses venture capitalists in search of projects of commercial value that they can fund. It's a truism that this is possible only at institutions which have a high level of research focus. Such universities would provide opportunities for the growth of new enterprises in the country, provide employment and thus contribute to the economy of the nation.

Addressing Globalization in Engineering Education

One of the major fallouts of globalization is that companies employing engineers are increasingly multi-national, geographically distributed, and hence must deal with diverse business cultures and governmental regulations. The art of engineering design needs to take account of both local and global cultural perspectives as there are variations in engineering practice due to differences in cultures, legal systems, environmental regulations and customer preferences. Thus, engineering teams must progressively be more diverse in terms of culture and language and hence there are increased demands for engineers with international perspectives. It follows that engineering education must change to better prepare engineers to work in global environment.

Enhancing Engineering Education in India

The experience of the IITs and their successes over the past 40 to 50 years is valuable for an appraisal of the state of engineering education in India. No doubt, the IITs have made global impact in terms of their teaching programmes. Yet they still have a long way to go to make the same mark through their research programmes. The situation in India is a rather complex one. We have a very large number of high quality aspirants for higher technical education. But the number of engineering colleges of global standards is not sufficient. In contrast, several western countries have quality institutes but not enough students.

As a consequence, technical universities of the western world keep attracting a talented pool of students, especially from India and China. Today, not only post-graduates, but a large number of undergraduates are also going to universities abroad; even though the cost of education at some places is many times higher than in India. This is mainly because there are not enough world-class institutions in India.

The strategy to meet this lacuna lies in *co-operation*. Institutions with higher reputations need to share their expe-

rience with others. In the arena of higher technical education IITs should take the lead to network with the NIT and other select engineering colleges to begin with. Such tie-ups will go a long way towards augmenting technical education in India. In this enterprise, we must utilize the *Distance Education* mode, i.e. foster web-enabled learning.

Should India extend and globalize its education system? For one it would be an opportunity for us to benchmark our education globally as well as an opportunity to earn. On the other hand, with a large number of high quality students available in India, need we go abroad? Besides, an implicit challenge in this is to produce high quality faculty for foreign campuses. Perhaps as an intermediate approach we should reach out to countries in the Asian-African region where higher education requires guidance. IIT Bombay has already initiated such exercises with a few countries such as Nepal and Cambodia.

However, such a process may necessarily act both ways, and one needs to consider the implications of foreign universities setting up campuses in India. This may have a positive impact in that there could be more high quality education institutes in the country, which may provide healthy competition to Indian universities. However, there are concerns that the foreign providers may charge much higher fees; and salaries may be substantially higher, which may cause migration of faculty and make the problem of faculty availability more acute for the Indian institutions. The Indian institutions, thus, need to evolve a clear line of thinking to counter these challenges.

The Turning Point

Globalization has already had an impact and will continue to mould higher technical education. India is at a point where it can produce a high number of knowledge workers. Indeed, the country *will* need a large base of knowledge workers to play well a role as a leading knowledge-driven economy in the world. This offers an enormous opportunity for globalizing our higher technical education, a challenge that we all must pursue with vigour and enthusiasm. India will need to gear-up by revitalizing its institutions of higher learning with greater freedom and momentum. For this to happen, we all will have to be partners in the process.

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Higher Technical Education: A Borderless Future?

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While services currently account for over 60% of global production and employment, they represent only about 20% of total global trade. However, the new generation of ICTs has the potential to enhance this trade by imparting traditionally local services an unprecedented international mobility. The recent success of BPOs in banking, health and other sectors are testimony to that prospect. The GATS, *General Agreement on Trade of Services* (a companion to the GATT, *General Agreement on Tariffs and Trade*), which was launched during the Uruguay round of talks, and whose results came into force in 1995 is aimed precisely at unbarring international trade of *services*; which *inter alia*, includes 'education'. Unlike with any other services, the annexation of education in GATS has ushered in a fervent debate not only amongst national policy-makers but within the academia as well.

Not unexpectedly, the opinion within the international academia is a divided one. Those who are for liberalization of the education sector argue that such a move will allow greater accessibility of higher education by the global population. Traditionally, however, the academia has perceived itself as very distinct from trade, and rather as a 'disinterested' generator and provider of knowledge. It would not be inaccurate to say that this still remains the majority viewpoint within the academia. It is pointed out that the key purposes of the academia are securing wider social and cultural benefits. Thus, those skeptical of the current WTO developments maintain that regulating education through trade frameworks and a consequent 'commoditization' of knowledge can cause the academia to lose its non-profit character, which is essential to its creative functioning.

Nevertheless, the current world-order, both in terms of social and technological parameters, is itself far too complex for academia to remain isolated from. On the one hand buoyed by rapid technological advances, higher education sector has emerged as one of the most important components of global strategy; on the other hand, the world today is in the grip of an unprecedented demographic expansion, mainly in the developing economies. As a result of these twin pressures the demand for higher education, particularly professional courses and *non-traditional* delivery modes, is increasing in most countries. But while demand is growing, the capacity of the public sector to satisfy the demand is diminishing. This is due to budget limitations, the changing role of government, and increased emphasis on market economy and privatization.

A mimicry of business?

There is nothing new in academic mobility for students, scholars, teachers and knowledge, as this has been part of higher education for centuries. What is new today is that *academic programs* and *providers* are also moving across borders. Corporate and for-profit educational institutions are emerging. Also, branch campuses and franchise arrangements are being developed across nations. Economic logic is increasingly driving this international 'supply' of education. Propelled strongly as they are, by the emerging ICTs and of course, the economic *zeitgeist* of globalization, these realities may be irreversible. What then are the likely further impacts of liberalization on higher education? How does the academia capitalize on the benefits of the ongoing transformation and minimize the threats to its traditional strengths?

In a sense, the academia is already witnessing a transformation towards acquiring features that are more

entrenched in business. TRIPS (Trade Related Aspects of Intellectual Property Rights), another trade agreement like GATS, has already impacted the academia, owing to which there is now an enhanced emphasis on issues of patenting and copyrights in higher learning institutions.

In parallel with the course of economic globalization, the academia has been witnessing a networking process which may be better termed as *internationalization*. Institutions of higher education are building partnerships over academic and research programs across countries, but in a non-profit sense. There is considerable potential for mutual benefits for all partners and important spin-off effects for research, curriculum development and teaching, provided the traditional academic values of openness and sharing are sustained. Will the imposition of a trade-like management of such internationalization processes enhance their potential or will they be curtailed? Will the aim of seeking further *academic value* through such international networking be subjugated to the business compulsion of seeking relatively *short-term* economic value? The key approach within academia may lie in profiling the *longer-term* social and economic gains that may accrue from non-profit academic and research co-operation.

Harvesting the real advantages

Given the current global economic and demographic situation, flows in education services across borders will continue to take place. The level of gains that may accrue to different nations from such a development may be difficult to judge. But ideally speaking the emerging nations may stand to achieve the largest and most rapid gains. However, for this to happen, the voices of such groups need to be heard at global trade platforms. The benefits and risks associated with increased trade need to be anticipated well, so that national efforts to develop and enhance domestic higher education are not compromised. It is also necessary to establish the right frameworks for *quality assurance* and *accreditation*.

Though intricate and controversial, the case for liberalization of higher education can be argued even on the single ground that in spite of much support and concern, higher education remains a high privilege or beyond reach for large portions of the global population. Unlike in earlier times, the key constraint today is not the availability of knowledge but its distribution and assimilation. In disseminating education, today's technologies can easily help surpass such a limitation.

But this makes inevitable some degree of market-based thinking within the academia. For, the scale of operation would require that the resources are used most efficiently, without necessarily sacrificing the *egalitarian* spirit. The policy support from either national governments or from international bodies such as WTO needs to be in the direction of *reducing the risk* of such extension activities. In parallel, this would also require that the academia becomes more open to a cultural change that is needed in order to accommodate the responsibilities of extending itself beyond its traditional, local boundaries.

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Importance of Copyright Flexibility in Indian Information Policy

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India is poised to take considerable advantage of the global information revolution in addressing and leapfrogging many traditional developmental concerns. In this age of rapid increase in the volume and speed of information flow across the world, it is important to develop a national information-access policy that is resilient.

Most of the discussion in India relating to the information revolution [IR] and information access by common people has been framed either in terms of the development of low cost technological gadgets or through various channels of information delivery. These are important and crucial. However there is little serious discourse on precisely who or what will act as the gatekeepers for controlling the content layer of the information revolution. The role of intellectual property safeguards, in particular copyright, cannot be underestimated in its impact on the varied contents.

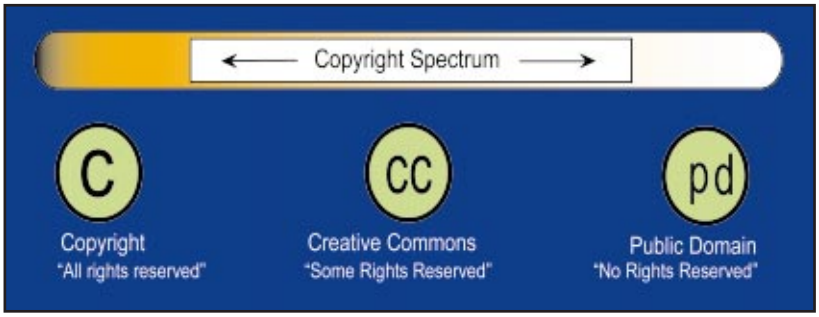
Traditional copyright, which is code for "all rights reserved" with the author, has the potential to intervene in the flow of information. From the end user's perspective, it is legally essential to always go back to the author for permission for further use of her creative work. This could range from copying for commercial use to making any adaptation for use in theater, film, music or text. The "fair use" exception allows users some freedom but its scope is increasingly being narrowed as we enter the digital domain.

In particular, it is the increasing length of the copyright

term which now includes copyright protection for life of the author plus sixty years that is posing problems for the new generation of authors. For instance, in a common situation, a deceased author of an out-of-print text [an orphan work] written in 1960, has its publisher either bankrupt or untraceable; one cannot therefore legally use any substantive part of the text, even if one genuinely sought copyright clearance. Inability to get copyright permission translates into locked up creativity.

Protecting Developing Country Interests

The need for arguing that India should widen its IP policy options rests on growing evidence that global IP, as mandated



through TRIPS/WTO, is being upwardly harmonized and increasingly aligned to the interests of western countries. The IP policy of North American and Western European nations are deeply influenced by the lobbying juggernaut of their very large knowledge-based industries, in particular, software, entertainment and pharmaceuticals. In their books Ha-Joon Chang ("Kicking Away The Ladder", 2002) and Ben-Atar ("Trade Secrets: Intellectual Piracy and the Origins of American Industrial Power", 2004) clearly show that developed western countries are consciously or unconsciously resorting to blocking or knocking away the development strategies of developing countries; the very same strategies that were themselves used by the former in moving up the developmental ladder.

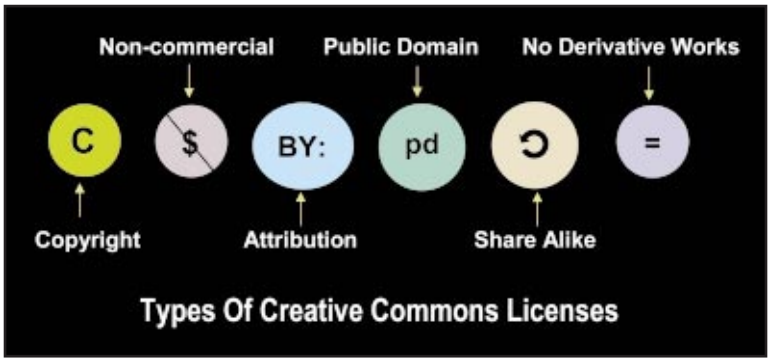
In addressing their development concerns, developing economies like India or China can take the lead in using and building intermediate, open-content or public domain oriented information access models, without attracting high institutional resistance from inside their respective countries. To some extent this could help pre-empt the possibility of their development paths being "blocked" by foreign nations.

The Creative Commons Approach

A specific example may help to highlight the above issues. For instance, let us briefly assess the impact of the copyrighting system on accessing both scientific and other academic journals for research institutions in India. The present copyright system permits journal publishers to acquire all rights from the author. The author on his/her part, acknowledging the marketing potential of the publisher, surrenders his/her copyrights. However under the "fair dealing" clause of the Indian copyright act, a user is allowed limited access to the content for personal or academic purposes. This "fair" access scenario could become technologically defunct with journal publications gradually shifting to the online mode of transmission. Large on-line publishing houses in response to growing piracy are beginning to place significant licensing and circumvention constraints on the ability of end-users to even minimally access copyrighted material. The important questions is how can authors deliberately avoid the copyright toll and make works of art/text more easily and flexibly available to the end user?

Possible solutions to the increasing use of copyright fencing do exist but one would have to go beyond the confines of the traditional copyrighting system. Authors may need to explore an alternative "some rights reserved" licensing system as made available through *Creative Commons* [creativecommons.org]. Creative Commons [CC] is basically an international flexible copyrighting licensing effort with various national chapters as its constituents. IIT Bombay has recently signed an MOU with CC to lead the effort in India.

Under CC, specific kinds of copyright licenses can be displayed by an author in a-prior manner so as to basically pre-empt the need by the user to take repeated permission from the author. There are a total of 6 licenses in CC: 1. Copyright; 2. Attribution; 3. No derivative works; 4. No commercial use; 5. Share alike & 6. Public domain. These licenses can provide considerably greater amount of flexibility to the user as granted by the author. For



instance, the "attribution" license of CC requires that any user of the work merely provide proper attribution to draw on a piece of work. No advance clearance is required from the copyright holder. Such a license could easily address any future need for copyright clearance required for orphan works, or even prevent large companies from locking up content.

The present author is of the opinion that the use of flexible copyright mechanisms is vital for a developing country like India to improve her research abilities, produce more innovation and allow it to become a stimulus for growth. The building blocks of research and creativity rest on the overall *access* and *cost* of basic data, which in turn is decisively influenced by the nature of the copyright system. By widening our IP policy options we can truly influence the nature and access of content in the midst of India's information revolution. The Public Library of Science, Free Access to Science, Creative Commons, Human Genome Project, Digital Library of the Commons are just some among the many interesting global initiatives of increasing our creative output.

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Integrating Village - Industry with Human and Animal Power

Narendra Shah, Centre for Technology Alternatives for Rural Areas (CTARA)

Harnessing human muscle power as well as animal energy has been in use since the eighteenth century. When pedaling in a circular motion at sixty to eighty revolutions per minute, with the use of toe clips, almost every muscle in the human legs can be used to make energy. On an average, a healthy person in the age group of 13-60 years can impart about 75 Watts (0.1 HP) and a bullock can give about 375 Watts (0.5 HP) on a basis of 6 hrs work in a day.

Pedal / animal power can be incorporated in the lives of families living in rural areas to improve the quality of their lives in an entirely environment friendly manner. Most of the villages where electricity is not available (or if 'grid connected', availability is extremely uncertain) pedal/animal power is a promising substitute, and can be an eco-sensitive energy solution for a range of decentralized rural applications (see box).

Applications of Pedal/Animal Power

- Rural Industry: Wood carver, stone polisher and buffer, jeweler's lathe, and pottery wheel and small scale elec tricity generation
- Food Processing: Appliances such as a juicer, potato peeler, decorticator, cherry pitter, or a butter churn can also use with pedal power
- On farm: pedal power can be used to pump water, thresh and clean grains etc

Prototypes developed at IIT Bombay

Recent work on development and testing of pedal power and animal driven energy generation prototypes at CTARA, IIT-B, has been supported by KVIC-Mumbai. Several ongoing projects have led to the demonstration of pedal power use in:

- Potters wheel
- Battery charging
- Water Pumping
- Wood Turning Lathe
- Paddy Threshing

Details of some of these devices are presented below.

Potter's Wheel

Pedal-powered Potter's wheel consists of a driving mechanism, seating arrangement, rotary wheel and plastic splash pan. The driving mechanism consists of a chain and sprocket drive with set of bevel gears, which convert human energy into horizontal rotary motion and transmits it to the wheel. The wheel itself acts as "Potter's Wheel" as well as flywheel that curbs the effect of the unevenness associated with pedaling. The wheel is designed to have a full range of speed control from slow revolutions to fast (i.e. 100 to 300 rpm). It can hold both fast and slow speed accurately under load. A prototype has been installed at Yusuf Meherauli Centre, Tara Village, Dist Raigad (Maharashtra) supported by KVIC, Mumbai.

Pedal Power Electricity Generator (Battery Charger)

A large number of users usually meet the shortages in grid-supplied electricity by kerosene/petrol gensets. However, the gensets are often expensive for use by poor households. A Pedal-powered generator provides a method of generating electricity by means of a suitably modified bicycle. Human / mechanical energy is converted into electricity by means of a Direct Current (DC) generator that is connected by a chain to the flywheel. The energy created by the DC generator can be stored in various types of dry/lead-acid batteries. Also, energy that is stored within the battery can be utilized as DC current for use in DC appliances such as those found in automotive mobile homes. If Alternating Current (AC) appliances are in place, then an inverter must be used to transfer the 12 volts of DC current into the standard 230 volts of AC for usage by these appliances. The unit can generate 80W power by pedaling for 1hr @40-50rpm, which is enough to light two lamps (10W) for four hours. Supported by KVIC (Mumbai), a prototype of this type of generator has been recently field-tested at Yusuf Meherauli Centre, Tara Village, Raigad (Maharashtra) and is currently being used at the site of Dapoli Engineering Works in Konkan area of Maharashtra.

Reciprocating Double Acting Water Pump

This device consists of two *reciprocating pumps, a flywheel, cycle frame, chain and sprocket drive, and connecting rod*. A single person can operate the pump. Each pump can produce a discharge of about 24 lit/min. Discharge of 48 lit/min (2880 lit/hour) can also be obtained at normal operational (pedaling) speed. In the remote rural areas, where neither electricity supply nor diesel engines are easily available, such pedal driven pumps can be used as alternative / standby for electric

or diesel pumps for pumping the water from well or tank or *nala* (with a maximum suction head of 20 ft.). CTARA at IIT Bombay has identified several sites in the Konkan area, where although water is available for use, electrical pumps are beyond reach of the consumer. In such instances, pedal-powered pumps can be put to use. Field performance of these newly designed pumps will be assessed at one of these sites soon.

Animal Driven Electricity Generator

This variant of the pedal-powered electricity generator uses animal motion as the productive source. The prototype unit has been developed and tested within the framework of a KVIC-Technology Interface unit project at IIT Bombay. The *Proof of Concept* (POC) design was installed at Aarey Milk Colony (Mumbai) for the initial testing. The team working on this project is exploring joining a partner animal farm nearby to further test the feasibility of the machine. The device requires a pair of bulls or buffalos for providing the input power. Some of the attractive features of the contraption are as follows:

- Ergonomically suitable for animals.
- A permanent magnet DC generator generates about 120 W (with single bull), which can be used for lighting through CFL lamps or battery charging.
- An inverter can be used to run conventional AC gadgets.
- Components used are easily available in the market and can be fabricated and/or repaired at a small fabrication shop available in villages.

Organization (NGO or individuals or entrepreneurs) desiring to utilize the prototypes for further testing and dissemination can contact CTARA.

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Tsunami Characterization Studies

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Tsunamis are sea waves generated as a result of water displacement in the sea. This could happen due to a variety of reasons: earthquakes, landslides, volcanic eruptions, explosions, impact of cosmic bodies and sometimes, or even detonation of a nuclear device. However, like earthquakes, prediction of a tsunami is complicated and difficult. But as was witnessed by the recent tsunami that originated at Sumatra on December 26, 2004, the damage and devastation by tsunamis can be far more serious than that by the earthquakes. To minimize such losses, it is important to understand how tsunamis are generated and can affect our lives.

Tsunamis are normally a series of sea waves (*not* of a 'single huge wave') caused by a natural or artificial disturbance that vertically displaces the water column above it. So far, most destructive tsunamis have resulted from large earthquakes, with epicenters/fault lines near the ocean floor. Vertical displacement of the earth's crust along such fault lines can generate very powerful waves which travel with great speeds across oceans causing devastation along their path. The speed of a tsunami wave is decided by the volume of displaced water (i.e. depth of water column where it gets generated). The speed diminishes, while the wave height *increases* as these waves approach the coasts.

The Nature of Tsunamis

According to the *continental drift/plate tectonics* hypothesis, the continental plates, each about 50 mile thick, are continuously moving due to the convectional currents generated by the heat transfer processes in the earth's mantle. New crust is being formed at the sea floors where the plate boundaries diverge. These plates converge at some locations on the earth leading to friction, subduction and demolition of the plate boundaries. As a result, these plate boundaries are a constant source of earthquakes all over the earth. When these earthquakes occur beneath the sea, the water column above gets displaced. This displaced water column in turn pushes the adjoining volume of water out in the form of a wave that gives rise to a tsunami. However, the amount of vertical displacement is what determines the tsunami wave features, and not all disturbances underneath the sea necessarily lead to tsunami waves.

Tsunamis differ from the wind generated waves in several ways. The most important difference is wind generated waves normally have a wavelength of up to 100-200 m whereas the wavelength of tsunami waves can exceed 500 kms. Tsunami waves behave as shallow water waves due to their long wavelengths and hence travel very fast in deeper waters (upto 900 kms/hr) with minor energy loss. Due to very small (sub-meter) amplitudes they are not even felt aboard ships. But as they get into shallower waters they slow down leading to increase in their wave heights. This result from piling up of energy and decrease in the distances between individual waves (called `shoaling').

The shoreward propagating energy results in the bottom friction and turbulence resulting in heavy coastal erosion. The elevation to which such destruction can happen is termed as `run-up level' and is expressed in meters above the mean sea level. The run-up levels are determined by the obstructions on the path of the wave, like geomorphic features, thick vegetation growth as well as artificial structures. The extent of tsunami damage is decided by the 'run-up levels', which in turn are

dependent on the resistance offered by the features on land, like topography and land use. Hence, tsunami characterization studies mainly include the understanding of *local geomorphology* and *land use changes and measurement of run-up levels.*

Tsunami Studies by IIT Bombay

The Centre of Studies in Resources Engineering (CSRE, IITB) is participating in the DST sponsored project on mapping the changes that have occurred on the southern islands of the Andaman and Nicobar group due to the recent tsunami. About seven scientists and engineers are part of the CSRE team. The study involves a multi-pronged approach: analysis of the pre- and post-tsunami *remotely sensed data* of the region followed by selective field checks to assess changes in the geomorphology, land use and the shore line, and measurement of the inundation levels all around these islands. Some of the preliminary observations are as follows:

1. Inundated areas have been demarcated on the basis of tonal variation in the post event satellite sensed data, in Car Nicobar, Camorta, Nancowry and Trinket islands (fig. 1) It is an important finding considering a thick ever green tropical forest covers these islands.

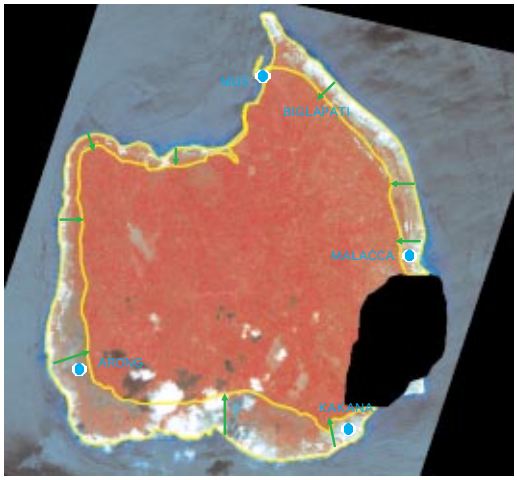
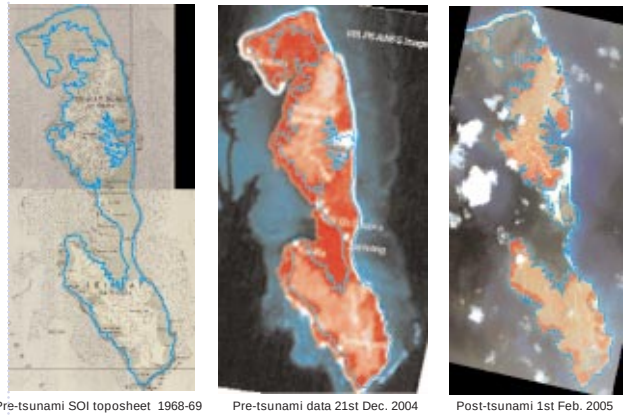


Fig.1 Inundated areas in Carnicobar

2. Depending on the terrain conditions – geomorphology and land use – run-up levels are observed to vary. In Car Nicobar island, the maximum run-up level observed in Big Lapathi was 6m, whereas in Malacca, Arong & Aukchaung it happened to be as high as 7m, nearly 1.2 kms inside from the shore.



Pre-tsunami SOI toposheet 1968-69 | Pre-tsunami data 21st Dec. 2004 | Post-tsunami 1st Feb. 2005

Fig .2 Shoreline changes in Trinkat Island

3. Trinket island showed maximum amount of shoreline changes with its central part largely submerged due to high erosion and subsidence of the land (fig. 2).
4. It was found that with exceptions of few areas like Trinket island, there have been marginal or no changes in the geo morphology of the study region. But severe erosion has been quite common in many coastal areas including northern parts of Camorta island (fig. 3).

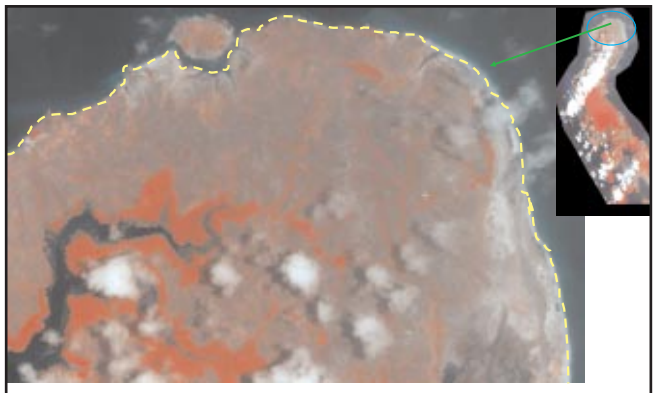


Fig 3 Highly inundated shoreline of northern Camorta

5. There is an overall subsidence in the southern islands leading to submergence of coastal areas (including man groves) in the water. As a result most of the mangroves – which can survive only in the intertidal regions – are dry ing out (fig. 4). The coconut plantation along the coast is also wiped out in the Car Nicobar Island due to the force of the incoming tsunami waves.

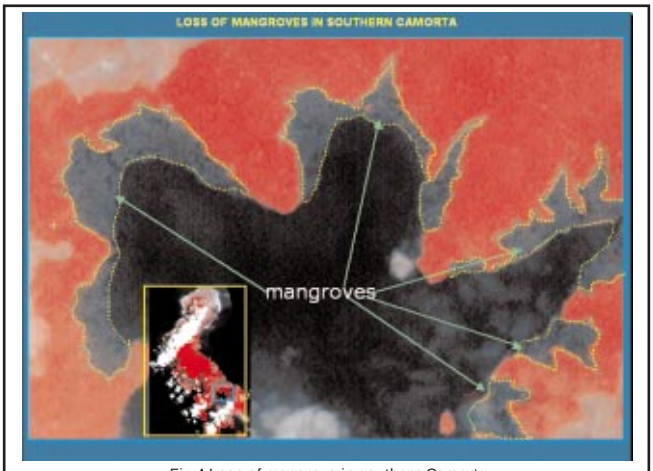


Fig 4 Loss of mangrove in southern Camorta

6. *Synthetic Aperture Radar* image of Car Nicobar island has very little resemblance with the land use map generated from the VNIR data FCC, although it is possible to demarcate the inundation line in a few places. Interferometric studies aimed at understanding minute changes in the terrain morphology have not yielded encouraging results because of high vegetation cover in most of the study region.

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