Building Advanced Education & Learning
Bridges with the Third World: Lessons from an NNIN Experiment

international Winter School for Graduates (iWSG)

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Charles N. Mellowes Professor in Engineering
Cornell University

Thanks to all past participants, too numerous to list here, whose photography and insights from discussions are in this talk

Tiwari_iWSG_at_NSOF, May 24, 2011
The post-world war II period has been a period of big changes – socially and technologically, with newly independent Asian countries and colonized New World countries coming into their own – particularly over the past decade and a half.

- Development of the citizen scientist/engineer by fostering global awareness of future leaders, sharing knowledge, and promoting cooperation among future leaders and academics

iWSG attempts to accomplish this objective by bringing together a select group of outstanding graduate students and adventurous faculty in an intense course of common interest in an emerging "nano" area in a third world country.

75-150 local students and faculty participate in the event
India

... Indian software industry, Tata Nano, pharmaceuticals, GE making inexpensive medical diagnostics, ... GDP expanding at >8.5%/yr

Sources: E&PW, WSJ, NYT, IEA, ...

Indian IT: Export's Share of Total Output (1991-2009)

- Export
- Domestic

Sources: E&PW, WSJ, NYT, IEA, ...

India

GE ECG in India ($1500) developed for $500K

Pharmaceuticals in India

From Wikipedia, the free encyclopedia

The Indian pharmaceutical industry is the world's second-largest by volume and is likely to lead the manufacturing sector of India. India's bio-tech industry clocked a 17 percent growth with revenues of Rs.137 billion ($3 billion) in the 2009-10 financial year over the previous fiscal. Bio-pharma was the biggest contributor generating 60 percent of the industry's growth at Rs.8,829 crore, followed by bio-services at Rs.2,639 crore and bio-agri at Rs.1,936 crore. The
Impact of International on USA

nationwide phenomenon. Here are some characteristics of the engineering and technology companies started in the U.S. from 1995 to 2005.

- In 25.3% of these companies, at least one key founder was foreign-born. States with an above-average rate of immigrant-founded companies include California (39%), New Jersey (38%), Georgia (30%), and Massachusetts (29%). Below-average states include Washington (11%), Ohio (14%), North Carolina (14%), and Texas (18%).
- Nationwide, these immigrant-founded companies produced $52 billion in sales and employed 450,000 workers in 2005.
- Indians have founded more engineering and technology companies in the US in the past decade than immigrants from the U.K., China, Taiwan and Japan combined. Of all immigrant-founded companies, 26% have Indian founders.

V. Wadhwa, A. Saxenian, B. Rissing and G. Gerreffi, in “America’s New Immigrant Entrepreneurs”
India

But, a 1.2B population, abject poverty, increasing disparity

Income levels: >$34K/yr for 2.5 million and <$3K/year for 111 million (an increase of 10 million in past 6 years)


<table>
<thead>
<tr>
<th>Development</th>
<th>1/3rd of country has benefited; 800 Million has not</th>
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</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>400M+ w/o electricity</td>
</tr>
<tr>
<td>Water</td>
<td>130M w/o any water (i.e., no community access)</td>
</tr>
<tr>
<td>Road</td>
<td>~70% of villages inaccessible by asphalt road</td>
</tr>
<tr>
<td>Food</td>
<td>Food inflation higher than general inflation (currently ~10%)</td>
</tr>
<tr>
<td>Education</td>
<td>~½ of 6-14 year old in &quot;school&quot;, ~50% habitation has no primary school</td>
</tr>
<tr>
<td>Calorie consumption</td>
<td>Declining for bottom 50% since 1987 while obesity in rich</td>
</tr>
<tr>
<td>Childhood</td>
<td>46% of children below 3 yrs old too small for age (UNICEF)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>China has 10x electric power</td>
</tr>
<tr>
<td>Corruption</td>
<td>~50% of economy; was ~40% in 1996, ~5% in 50’s</td>
</tr>
</tbody>
</table>

In India,

By Arno Senan

NEW DELHI–India has an elected prime minister and Parliament and a basic democracy. But avoid public outrage over corruption and the widespread perception that the nation is poorly governed, the Supreme Court’s 28 judges increasingly are a source of hope.

The court has turned hyperactive in the past year, issuing itself into matters involving corruption and money laundering investigations, issuing orders to agencies on issues from malnutrition to caste violence to education, and venting a frustration held by many Indians but rarely articulated from such a lofty perch.

“What the hell is going on in this country?” asked Supreme Court Justice B. Sudershan, but the court’s statements are now arguments in a public-interest case brought against the government for not pursuing tax dodgers and the authorities the following week arrested a rich businessman from the western city of Pune who authorities believe has billions of unreported dollars—or “black money” in Indian parlance—in bank accounts outside the country.

India has the world’s second-fastest-growing major economy of 130M w/o electricity and has been on a path of economic liberalization for the past 25 years. Yet there is growing frustration among millions of Indians that the government is failing to crack down on graft, ensure the middle class and poor get their fair share of the fruits of growth, and do away with outdated social structures.

The Supreme Court has taken upon itself the task of trying to solve many of these problems. After hearing a case on malnutrition on Saturday, the court ordered the government to distribute five million tons of food grains to the poorest districts of the country, saying state-owned warehouses stocked with surplus food weren't getting to the needy. The court also told the government to distribute oil subsidies if it doesn’t.

People are a stark contrast.*

Civil-society activists are hopeful the court’s outside role in governance will force the other branches of government to address glaring social and economic problems.

But some judiciary experts and government officials say the court is overstepping its authority and trampling on the separateness of powers in the Indian constitution. They also say judges are going beyond their capabilities—by directing the activities of criminal investigators and trying to stop policy in complex areas where they have few resources to follow up on orders they issue.

“It is perfectly all right to let people direct the government, and it is perfectly all right to have direct control of the police. It is not perfectly all right to let people order a blanket of power in different bureaucratic agencies, because they don’t have the staffs to do it,” said one government official, adding that it is also unconstitutional.

The court has been accused of error in action. There are cases in which the courts have been found to exceed their authority, and some say the court is no longer the final arbiter of law.

* WSJ, 05-06-2011

Tiwari_WSG_at_NSf, May 24, 2011 9
But you can search who is below poverty line on the web! e.g., Sandeep Tiwari

Mumbai, 2010

The existence of gated communities is often the earliest sign of trouble.

The Galleon Case
Graduate of IIT, 1971

How Rajat Gupta Came Undone

The former McKinsey head was a gifted member of the corporate elite. But a tape of his voice, divulging secret details of a Goldman board meeting to a convicted hedge fund manager, cost him what amount of money can buy

US Attorney for Southern District of NY Born, Punjab (India)
IITs better than US institutes,

But the moment of supreme irony comes when she interviews Infosys co-founder NR Narayana Murthy and asks him about his son's education.

Murthy: Well, my son, he wanted—probably wanted to do computer science at IIT. To do that, you have to be in the top 200 and he couldn’t do that, so he went to Cornell instead.

Saha: (sawed voiceover amid footage of IIT students on campus): Think about that for a minute. A kid from India using an Ivy League university as a safety school. That’s how smart these guys are.

Murthy: I do know cases where students who couldn’t get into computer science at IIT, they have gotten scholarships at MIT, at Princeton, at Caltech.

The Expectations and the Stress

IIT’s stressed-out geeks opt for suicide solution

Management and counseling cells come under fire for failing to tackle spike in deaths

Sai Manish
Chennai

By the time Nithin Reddy’s door on the third floor of the Jamuna Hostel in IIT Madras was broken open by his friend after a frantic call from his father, it was too late. The 24-year-old’s limp body was hanging from the fan.

Barely 48 hours before he cut his life short on 4 May, Nithin had made his intentions clear to his father and friends. "I tried hard but I lost," wrote Nithin, lovingly called 'Swamy' by his friends, on his Facebook wall. He emailed his father A Lakshman Murthy who works in DRDO and told him he was going to kill himself and what should be done with his possessions after he was gone. By the time Murthy, who works in New Delhi, alerted the local guardians in Chennai, it was all over.

On 2 May, Nithin, a final-year MTech (mechanical engineering) student was ordered to do another semester, which meant he could not pass out with his batchmates and faced the prospect of losing the lucrative job that he had landed at a Bengaluru-based software company.

Almost a 0.5% rate over a program
India

- Nonviolent political success of an oppressed society against an oppressor
- Democracy in the midst of mass illiteracy and a history of feudal and religious and ethnic divisions
- ...

Society, Education, Values, Technology

The tension of Values with Technology:
Content to Context - of creators with users,
of technology generators with the greater society
Number of US Participants, Topic and Location

**iWSG1:** 12; Organic Electronics & Optoelectronics    IIT Kanpur
**iWSG2:** 10; Nanoelectronics with emphasis on Silicon    IIT Mumbai
**iWSG3:** 13; Science and Technology of Nanofabrication    IISc Bangalore


Faculty from: ASU, Columbia, U Colorado, Cornell, GaTech, IBM, UCLA, U Illinois, U Minnesota, U Washington

**Students who show promise for leadership**
– in academia and industry, and a global interest
Selected from national pool

**iWSG Locations**

*Khandwa:* Tribal region, forests cut, tribals shifting to agriculture.

*Dharmasthala:* Highly bio-diverse and progressive.

*Paralakhemundi:* Tribal region, still forested, but with rich mining resources being eyed by industry.
# Course Schedule

<table>
<thead>
<tr>
<th>Monday, Jan. 3</th>
<th>Tuesday, Jan. 4</th>
<th>Wednesday, Jan. 5</th>
<th>Thursday, Jan. 6</th>
<th>Friday, Jan. 7</th>
<th>Saturday, Jan. 8</th>
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<tbody>
<tr>
<td>9:00-10:15</td>
<td>Scope and Objectives</td>
<td>Lithography: Resist, Optical, Self Assembly</td>
<td>Inauguration of New Clean room at the “Centre for Nano Science and Engineering”</td>
<td>Material Modification: Implantation, Annealing and Diffusion</td>
<td>CMOS and MEMS Process Integration</td>
</tr>
<tr>
<td>-N. Bhat</td>
<td>-Illic</td>
<td>-Dr. R. Chalambararam, Principal Scientific Advisor to Govt. of India</td>
<td>-Campbell &amp; Tiwari</td>
<td>-N. Bhat</td>
<td>9:00 - 9:45 Society and Technology</td>
</tr>
<tr>
<td>Centre of Excellence in Nanoelectronics : Background and Vision</td>
<td>-Illic</td>
<td>-Van Zagrooek</td>
<td>Characterization: MEMS Devices and Dynamic characterization</td>
<td>-Pratap</td>
<td>9:45 - 10:10 Camera Trap Technology for Wild Life Conservation</td>
</tr>
<tr>
<td>- S. Mohan</td>
<td>Indian Nanoelectronics Users Program Empowering Research</td>
<td>Lithography: E-beam, FIB, Soft Lithography</td>
<td>Tour of the facility, Poster session by select PhD students at IISc</td>
<td>Characterization: Optical Microscopes, Ellipsometry</td>
<td>-A. Pijet</td>
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<tr>
<td></td>
<td>-Tiwari</td>
<td>-Van Zagrooek</td>
<td>-Böhringer</td>
<td>-Varna</td>
<td>10:10-10:35 Photovoltaics for Rural Electrification</td>
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<tr>
<td>10:15-11:45</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>-A. Nayar</td>
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<td></td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>10:35-11:00 Water Purification Technologies</td>
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<td></td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>-R. Chankaya</td>
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<tr>
<td>11:30-11:45</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>11:00-11:30 Break</td>
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<td></td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>11:30-12:00 Food-Nutrition-Health : Technology and Tradition</td>
</tr>
<tr>
<td>-Campbell</td>
<td>-Illic</td>
<td>-Van Zagrooek</td>
<td>-Böhringer</td>
<td>-Varna</td>
<td>12:00-12:30 Crisis in Farming: Reviving Green Revolution and Millers</td>
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<tr>
<td></td>
<td>-Campbell</td>
<td>-Böhringer</td>
<td>-Raphan</td>
<td>-Varna</td>
<td>-Dinesh Kumar</td>
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<tr>
<td>1:00-2:00</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>12:30-1:00 Malama Gandhi and Quantum Enigma : A suggestion to Nano Scientists and Technologists T.S Ananthu</td>
</tr>
<tr>
<td>2:00-3:15</td>
<td>Deposition and Growth Processes: Vacuum, PVD Processes—Sputtering and Evaporation</td>
<td>Precursor Synthesis Techniques for CVD</td>
<td>Stress and Defect Evolution during Thin Films Growth and In-situ Characterization Techniques</td>
<td>Characterization Low temperature Experiments, Chirp Spectroscopy, Life Time Measurements of Electron Bubbles</td>
<td>Applications to different Technologies</td>
</tr>
<tr>
<td>-Campbell</td>
<td>-Shoreshanker</td>
<td>-Raphan</td>
<td>-Ambarkish Ghosh</td>
<td>-Campbell</td>
<td>Conclusions and Discussions</td>
</tr>
<tr>
<td>3:15-3:30</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
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<tr>
<td>3:30-5:30</td>
<td>Lab Sessions</td>
<td>Lab Sessions</td>
<td>Lab Sessions</td>
<td>Lab Sessions</td>
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<tr>
<td>5:30-6:30</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
<td>Break</td>
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<tr>
<td>6:30-7:30</td>
<td>Veg &amp; Dance Ensemble</td>
<td>Dance &amp; Song</td>
<td>Dance &amp; Song</td>
<td>Dance &amp; Song</td>
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US Participants: Böhringer Karl F; Böhringer (Washington), Campbell Steve Campbell (Mizzou), Hockett; Ill; Rob Ill (Cornell); Tiwari Sandip Tiwari (Cornell), Van Zagrooek Bart Van Zagrooek (Colorado), Larry Goldberg(NSG); Other instructors from IIS (Indian Institute of Sciences).

All lectures will have short quizzes prepared by the instructor that will be handed out at the end of the session. To be returned by participants at the end of the day for grading by the lecturer.
And quizzes

17 of them.
One for each lecture
Very marked disparities in learning and critical thinking skills.

If a student is bright & passionate, ..., she/he still needs nourishment and nutrition. Challenge to be creative and “out of the box.”
The Technology Education Transformation

The “Old”

The Technology Education Transformations

Inexpensive Bootie Covers
The Tension

Technology intervention in society

- Control? Solve problems but also change vectors? Have’s and Have not’s?

- Technology that is non-locally grown versus external

- Nanotechnology context:
  - All encompassing!?
    - Intervention at a scale to influence all technologies? And if so its implications.
  - Interdisciplinarity and its tensions (whose and what culture, e.g.?)
  - Its claims to energy, environment and healthcare
    i.e. its expanding ambition and scope, unbounded space for innovation, and its claims to essentiality for civilization.

Field Trip Itinerary: iWSG3

<table>
<thead>
<tr>
<th>Date</th>
<th>Programme</th>
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<tbody>
<tr>
<td>9-1-2011</td>
<td>7:00 AM - 6:00 PM Halt at Dharmsathala</td>
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<tr>
<td>10-1-2011</td>
<td>9:00 AM - 11:00 AM Gather at SKORDP office, Brief of the programme.</td>
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<td>11:00 AM - 2:00 PM Energy innovations: Visit to SDM Engineering College.</td>
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<td>3:00 PM - 6:00 PM Livelihood innovation: RUDSETI, SIRI, Savanah garment unit</td>
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<tr>
<td>11-1-2011</td>
<td>9:00 AM - 1:00 PM Microfinance programs: Surudha, PBC, JVR, Cooperative Bank</td>
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<td></td>
<td>2:00 PM - 6:00 PM Agricultural Innovations: Visit to Farm, Possible activities in planting saplings</td>
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<tr>
<td>12-1-2011</td>
<td>8:30 AM - 5:00 PM Halt at Dharmsathala</td>
</tr>
<tr>
<td>13-1-2011</td>
<td>8:30 AM - 5:00 PM Health care innovation &amp; Education Initiatives: Naturopathy, SDM College, Belal High School, Ujire Kannada Medium school, Siddavan</td>
</tr>
<tr>
<td>14-1-2011</td>
<td>8:30 AM - 2:00 PM Manjusha Museum, Temple Meeting with Dr. D. Veerendra Hegade</td>
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<tr>
<td></td>
<td>2:00 PM Departure from Dharmsathala</td>
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<tr>
<td></td>
<td>9:00 PM Arrive in JSC guest house</td>
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</tbody>
</table>
House across the street from where we stayed during a visit to a village

Two daughters
Night
Homework

Schools as integrating environments for community access
Early Education; Tribal Schools from iWSG1

Up in Tribal Regions

In non-tribal villages
Contrasts; iWSG1

Tribals living off forests and land

Early Education: from iWSG2

In non-tribal villages
In tribal areas, where forest cover has been removed and the tribals have had to become marginal farmers, only time for children’s education is in evening.

The bottom 50% really do not have any meaningful education. Education for most comes from practical experience of daily survival.
Children’s desires similar everywhere
Schools that teach practical life needs in addition to academics
From iWSG1: The $25 School Science Box

The Country Considers Education as Key

Technical Bookstores; 1/10th US Prices

Education as the way out
Plastics! Technology as Good or Bad?

Community Experiences

Village life
Living with very little
But, a rich life through culture and sharing
Students’ Love of Humanity

Ground-up Community Organization

Small farmer organizations supporting common growth
**Bottom-Up: Cooperatives for Self-Help**

Rubber  
Milk  
Self-help groups eliminating middlemen

Garments

**Existentialism of a Stressed Planet: Technology**

Solar  
Wind  
Small-scale technology in an appropriate context

Hydro
Mass Transportation

Co-existentialism of a Stressed Planet

Finding a middle ground
Living as Part of Nature
Water

In Villages, if available

Bridges over Divides
And Being at Home in the New World
And Honest Fun Too; From iWSG2
Discussions

Outcomes and Prognosis

Archive of integrated lectures in an emerging subject on NNIN Web Site

Feedback

The field trip as a wonderful experience. (SKRDRP) is clearly a model for rural areas to develop themselves into self-sustaining and progressive societies.

I was struck most by the fact that most of the programs involved local people providing help, support, and education to each other, rather than an outside group imposing help.

Among the things I particularly enjoyed was the visit to the hydroelectric village and the science experiments with the high school students.

My two favorite sites were the pico hydroelectric plant and SELCO. SELCO is a great model of using technology to solve problems in developing countries. They are developing appropriate (technology) that meets the local populations’ need. The pico hydroelectric plant was also an example of an appropriate technology. It was environmentally friendly and met the needs of the local community.

Most student participants are still in graduate school
I have never been able to sit under the stars and just think... Just think about how a technology that is so cutting-edge yet practical to implement, that we think it could "help" people in a community culturally, economically, and socially different than our own. I came to many conclusions over the course of my time there, but one of them was that there is no panacea that engineers can create to solve all the world's problems. Many times the solutions we believe are ingenious tear apart communities and destroy cultures that have existed harmoniously since the beginning of time! So I wondered, what is my role here? I have to solve relevant problems because that is the reason that I became an engineer but to solve them responsibly I must also understand the cultural, ethical, and social implications of my solutions...

Common Themes in Response

Equal opportunity for all
- Shelter
- Health (disease, food, water, ...) and treatment of disease
- Education
- Happy and sheltered childhood – sanctuary from the tensions of the reality of the world

And these cannot all be separated; they are integrated in a common whole that we call Values

And,
- Inter-faculty joint projects
- Student-student long term international connections
- Even some redirection in student research directions
- A global perspective to humanity's needs and what science can do
This talk is a personal reading of the experience.

With unconditional love to the nation of my birth and my adopted home and the nation of my family.