Synergising Industry- Academia Linkages in India- An Academic Perspective

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Global Competitiveness Index

- Business, industry – globally competitive?
- World Economic Forum – Global Competitiveness index of different countries (WEF, 2012)
- One key parameter – Innovation capacity index
  - Quality of scientific research institutions
  - Company spending on R&D
  - University industry research collaborations
  - Availability of scientists and engineers
  - Govt procurement of advanced technology
  - Utility patents
# Global Competitiveness: Innovation Capacity Innovation Capacity Components Index

<table>
<thead>
<tr>
<th>Country</th>
<th>Innovation Capacity Index</th>
<th>Quality of Scientific Research Institutions</th>
<th>Company spending R&amp;D</th>
<th>University – industry research collaboration</th>
<th>Availability of scientists &amp; engineers</th>
<th>Govt. procurement of advanced technology</th>
<th>Utility patents (per million pop.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value Rank</td>
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</tr>
<tr>
<td>Brazil</td>
<td>3.8 31</td>
<td>4.1 42</td>
<td>3.8 30</td>
<td>4.2 38</td>
<td>3.8 91</td>
<td>3.9 52</td>
<td>0.9 60</td>
</tr>
<tr>
<td>China</td>
<td>4.7 15</td>
<td>4.3 38</td>
<td>4.2 23</td>
<td>4.5 29</td>
<td>4.6 33</td>
<td>4.4 16</td>
<td>2 46</td>
</tr>
<tr>
<td>India</td>
<td>3.6 35</td>
<td>4.5 34</td>
<td>3.7 33</td>
<td>3.8 50</td>
<td>4.9 21</td>
<td>3.5 78</td>
<td>0.9 59</td>
</tr>
<tr>
<td>Japan</td>
<td>5.8 1</td>
<td>5.5 11</td>
<td>5.9 1</td>
<td>5.1 16</td>
<td>5.8 2</td>
<td>4.1 32</td>
<td>352.9 2</td>
</tr>
<tr>
<td>South Korea</td>
<td>4.3 20</td>
<td>4.8 25</td>
<td>4.8 11</td>
<td>4.7 25</td>
<td>4.9 23</td>
<td>4.1 31</td>
<td>240.6 5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4.8 13</td>
<td>6.1 3</td>
<td>4.7 12</td>
<td>5.8 2</td>
<td>5.1 14</td>
<td>3.9 49</td>
<td>69.5 20</td>
</tr>
<tr>
<td>United States</td>
<td>5.2 7</td>
<td>5.8 7</td>
<td>5.3 6</td>
<td>5.7 3</td>
<td>5.5 4</td>
<td>4.7 9</td>
<td>339.4 3</td>
</tr>
<tr>
<td>Leading Country</td>
<td>Japan</td>
<td>Israel</td>
<td>Japan</td>
<td>Switzerland</td>
<td>Finland</td>
<td>Qatar</td>
<td>Taiwan, China</td>
</tr>
</tbody>
</table>

Source: WEF, 2012
Global R & D funding share

2009 R&D funding share in PPP, 1143 Billion US $

Source: Deloitte, 2011
Gross Expenditure on R&D

India Science 2010, Govt Of India
Private sector funding of R&D

2009 R&D funding share

Source: Deloitte, 2011
## R&D, GDP comparison

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>Brazil</th>
<th>China</th>
<th>UK</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (World Bank, 2010 (million))</td>
<td>1,170</td>
<td>195</td>
<td>1,338</td>
<td>62</td>
<td>309</td>
</tr>
<tr>
<td>GDP PPP per capita (current US$, WB, 2010)</td>
<td>1,477</td>
<td>10,710</td>
<td>4,393</td>
<td>36,100</td>
<td>47,184</td>
</tr>
<tr>
<td>GDP Growth (Annual %) World Bank, 2010)</td>
<td>9.72</td>
<td>7.49</td>
<td>10.30</td>
<td>1.25</td>
<td>2.85</td>
</tr>
<tr>
<td>GERD (% of GDP, World Bank, 2007)</td>
<td>0.80</td>
<td>1.10</td>
<td>1.44</td>
<td>1.82</td>
<td>2.72</td>
</tr>
</tbody>
</table>

Source: Nesta, 2012
R&D spending by source of funds

Source: Nesta, 2012
R&D spend by private sector domestic enterprises divided in selected sectors

Source: Nesta, 2012
Global R&D comparision

Source: Nesta, 2012
Leading Companies based on R&D spend

Source: Booz Co 2012, Economist
Frugal Innovations - India

Source: Nesta, 2012
Industry- University interaction

Source: Universities and Industrial Research, Konecny et al, 1995
Context

- Physics and Engineering
- Physics – Applications – energy, automobiles, medical, lasers...
- Short run- improve understanding of processes, innovative solutions to industrial problems
- Long run-help develop better processes, products, provide competitive advantage – cutting edge science and research
- Enthuse and attract bright students- excitement of real life problems
Questions

- How do we synergise industry-academia linkages in India?
- What can academia do to proactively enhance industry linkages?
Take Physics Local

- American Institute of Physics Initiative
- Reconnecting Physics to needs of society
  - Professional development opportunities for faculty and students
  - Continuing relations with alumni
  - Interaction with local industry / community
  - Research serving local needs
  - Faculty reward structure to encourage 1-4

Source: Hammer, Industrial Physicist
Industry connection (Take Physics Local)

- Industry – initiating / strengthening connections with Physics Department
  - Influencing student education, increasing student readiness for industry
  - Faculty / Students – Can assist in research, innovation, problem solving
  - Access to future work force – internships, co-ops, externships
- Initiatives – Donation of surplus equipment
- Training faculty to use equipment
- Courses / Seminars
- Linkages / Bond – Industry helps Dept focus on relevance
4% of the UK workforce is employed in Physics–based sectors, contributing 8.5% of the total UK economic output.

Deloitte, 2011
Share of UK jobs in physical-based sectors by broad sector, 2010

- **manufacturing**: 52%
- **architectural and engineering activities**: 15%
- **R&D**: 9%
- **transport**: 6%
- **electricity production and distribution**: 5%
- **defence activities**: 4%
- **oil and gas activities**: 3%
- **telecommunications**: 2%
- **construction**: 2%
- **technical testing and analysis**: 1%
- **recycling and waste and other services**: <1%
- **business services**: <1%

Source: Deloitte analysis using Business Register Employment Survey and Annual Business Survey

Source: Deloitte, 2011
Open call for proposals

Criteria:

- problems to be solved in a week (or a major solution must be within reach) one week and physics can make a clear contribution to the solution;
- it should be an urgent problem;
- company - willing to share detailed information.
2010 Physics with Industry - Netherlands

- Committee selected 5 problems
- Senior researchers recruited in related areas
- 67 participants- PhD students, researchers, professors

ASML, NXP (founded by Philips), TEIJIN, NIZO (The Food Researchers), FrieslandCampina
Develop self adhesive to stick on moist and icy substrates

Field of inserted charges during Scanning Electron Microscopy of non-conducting samples

Structuring with anisotropic colloids

MRI imaging of instruments - design of markers in relation to artefact size

Sticky Bubbles
Can physics tell the difference between a dead and living microorganism?

Cryogenic compatible displacement sensor

Electrical sensing and actuating of LED wavelength

PamFreezer: a solution to enable frozen biopsy logistics
University - Characteristics

Source: Crow, Kauffman 2008
IIT Bombay

Vision
To be the fountainhead of new ideas and of innovation in technology and science

Established year-1958
Modes of Collaboration

- Consultancy Projects
- Sponsored Projects
- Sponsored students – M.Tech/M.Des/PhD
- Sponsored Laboratory
- Chair Professorship
- Joint Research Centre
- Pre-competitive Research Consortia
Schematic of interaction between IIT Bombay and Society
IIT Bombay – Industry partnerships

- Chair Professorship
- Student Sponsorships
- R&D Projects
- Pre-competitive Consortia
- Laboratories and Facilities

Active engagements with ~ 350 Indian and International Industries
Research Centres / Consortia: Examples

- Centre for Excellence in Nanoelectronics
- PowerAnser Laboratory
- VLSI Research Consortium
- ISRO – IITB Research Cell
- National Mission on Education through Information and Technology
- Centre for Excellence in Telecom (IITB – Tata Teleservices)
- Geospatial Information Science and Engineering Lab
- National Solar Thermal Research, Testing and Simulation Facility
Research Centres / Consortia: Examples (Contd.)

- National Centre for Photovoltaic Research and Education (NCPRE)
- National Centre for Aerospace Innovation and Research (NCAIR)
- IGCAR – IITB Research Cell
- Climate Change Research Centre
- Healthcare Consortium
- Rural Development
- Proposed Centre of Excellence for Homeland Security
- Water Research Initiative
- Combustion
Solar Thermal Power Plant

Schematic of 1 MW Solar Power Plant
IITB-Solar Thermal Power Plant

Foundation stone
10 January, 2010

Solar Fields under construction

PTC Field

Heat Exchanger

LFR Field

Steam Generation

Turbine
Solar Thermal Power Plant

Schematic of the Solar Power Consortium
Solar Thermal Power Plant Simulator

Preliminary Version v 0.0

System Requirement

Supported Architectures

- x86 (32 bit)
- x64 (64 bit)

Supported Operating Systems

- Microsoft Windows XP
- Microsoft Windows 7
- Windows Vista

Prerequisites

- Microsoft .Net Framework 3.5 (Mandatory)
- Microsoft .Net Framework 2.0 (Prerequisite for Microsoft .Net Framework 3.5)
National Center for Photovoltaic Research and Education (NCPRE)

- **Programmes at IITB**
  - Ph.D., M.Tech., M.Sc., B.Tech., Minor programme at UG level
- **Preparation of Course Material**
  - Course Modules, Laboratory Kits, Teacher Training Programmes
- **Distance Education**
  - Web- and Satellite-based
- **Training programmes for Industry**
  - Short-term courses, Certificate programmes,
- **Indian National Photovoltaics Users’ Programme**
NCPRE Research

- **Si Solar Cells**
  - High Efficiency crystalline Si Solar Cells
  - 3D junctions
  - Silicon concentrator solar cells
  - Novel technology for contact formation using temperature sensitive paste
  - Slicing of silicon wafers for PV applications using wire electric discharge machining (WEDM)

- **New Materials and Devices**
  - Luminescence and QD concentrator solar
  - **Solid State Sensitized Solar Cells**
  - Transparent conducting oxides
  - Thin film solar cells
  - Investigation of spectral engineering of light absorption using nanostructures and infrared energy harvesting

- **Solar PV Systems and Modules**
  - Energy Storage
  - **Low cost power electronics solutions**
  - Novel approaches to energy generation using solar cells
  - Technology assessment and foresight
  - Product design; Rural deployment and testing of stand-alone solar PV systems

- **Characterization, Modelling and Simulation**
  - Material and cell characterization
  - **Performance and degradation evaluation of solar modules**
  - Reliability and performance
  - New and improved characterization techniques
  - Modeling and Simulation
Liberal explicit revenue sharing 70:30 Inventors, Institute, Explicit IP policy
Institute bears IP protection cost
Panel of attorneys, Simplified processes - online
Pro-active – abstract search Masters thesis, pre-publication drafts
Licensing web site, advertisement, brochures
SINE- Technology Business Incubator
Trend of Patent filing at IIT Bombay

Indian Patent Applications (1.1.97 to 31.12.11) : 241

Foreign patent applications : 64
(US, Europe, Japan, Canada, Taiwan, Brazil, Gulf)

PCT applications : 56

Patents granted (Indian+ Foreign) : 69+3
IIT Bombay Technologies for Licensing

Advt. in Times of India of IIT Bombay Technologies for Licensing

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Enquiries may be made by registering your details for Patents / Technologies available for Licensing and checking the specific technologies in the list given.

Request for more information may be sent to licensing@iitb.ac.in.
Dr. P. K. Patwardhan Award

Development and transfer of Super Critical Fluid Extraction Technology (2001)
M. Mukhopadhyay, Sandip Roy, S. L. Narayananurthy, Dr. S. Baser, all Chemical Engineering Department

Development and Transfer of Soil Biotechnology (2002)
H. S. Shankar, Chemical Engineering Department
Dr. P. K. Patwardhan Award


Matrix Heat Recovery Units (2005)
M.V. Rane, Mech. Eng.
Dr. P. K. Patwardhan Award

Mumbai Navigator- travel planning program for Mumbai (2006)  
Abhiram G. Ranade, M. Datar, K. Tilak, M. Srikrishna, A. Kotwal,  
R. Mehta, S. Sonare, & A. Jadhav  
Computer Science & Engineering Department

Hindi Wordnet and the Associated Software (2008)  
Pushpak Bhattacharyya & his team, Computer Science and  
Engineering Department
Dr. P. K. Patwardhan Award

Cryocooler Technology Development (2009)
Milind D. Atrey, Department of Mechanical Engineering

High quality low cost tumour knee prosthesis (2010)
B. Ravi and his OrthoCAD team, Mechanical Engineering
Attracting students to research

- Enthuse – first year students
- Support student Technology development initiatives
- Encourage learning by doing
- Alumni funded labs – U Mashruwala Innovation Centre, Wadhwani Electronics Lab
- Student Technical Activities Body – lectures, workshops, projects, competitions, tech clubs
Student Initiatives at IIT Bombay

Shwas – Underwater gliders

Matsya – Autonomous Underwater Vehicle (Robosub)

Biosynth

IITB Racing

Param – Student Satellite

IITB Robotics
Solar Decathlon 2014

Indian Team selected in top 20 across the world

- 70 students and 30 faculty mentors
- All academic curricula (B.Tech, M.Tech, PhD)
- Multi-disciplinary (Civil, Energy, Environmental Science, Mechanical)

Innovations planned in:
- Architecture
- Passive solar features
- Solar PV technology
- A/C and refrigeration
- Building materials
- Simulations & Optimization
- Building control systems

Partners
- Bluestar (HVAC)
- Philips (Lighting)
- Waree Energy (PV)
- BSE
- ISHRAE
- IITB Heritage Fund

Diagram showing ventilation strategy and sunpath above the structure.
Reaching Technology to the User
From Concept to Utilization

Natural Linkages exist
when margins and volume are high

Society for Innovation and Entrepreneurship
SINE Companies-Products

Unmanned aerial system-NETRA

IdeaForge

Jugnoo Solar Home Light

Railway berth LED

Ctech Labs Pvt. Ltd.

GRAM++

Bhugol GIS Pvt. Ltd.

Aqua Crop Project

Agrocom (AAQUA)
Summary / Recommendations

- India – high number of science graduates, limited industry-academia linkage
- Industry – new confidence, globally competitive
- Need to change perception and reality
- Pro-active role of academia – define roadmaps, create enabling environments
- Industry days (dissemination of research), physics industry workshops, internships, externships, seminars, Adjunct appointments
- Funding equipment, labs, chairs
- Consortia, Regional research pools
End-Note

You wanted to see me, Prof. Smith?
Yes, I have good news. I found funding for you...

F-F...

Yes, now, the project sponsors want you to wear this jumpsuit with their logos whenever you're in the lab. I told them it'd be no problem...

I also took the liberty of signing this contract for you. You didn't really want your soul, right?

...Funding...


Email: rangan@iitb.ac.in

Thank You
References

- India Science 2010, Govt Of India
- The Future of the Research University, Meeting the Global Challenges of the 21st Century, Carl J. Schramm, Ewing Marion Kauffman Foundation presented at Kauffman-Planck Summit on Entrepreneurship Research and Policy held June 8-11, 2008, in Bavaria, Germany.