GC 2012-5658: AN OVERVIEW OF THE CONTEMPORARY ISSUES IN ENGINEERING EDUCATION IN INDIA

Dr. R. Natarajan, Indian Institute of Technology

R Natarajan received his B.E. degree in Mechanical Engineering from the University Visvesvaraya College of Engineering (of the then Mysore University) in 1961. Subsequently he obtained the M.E. degree of the Indian Institute of Science, Bangalore; and the M.A.Sc and Ph.D degrees from the University of Waterloo, Canada. He has worked as a National Research Council Fellow in Canada, and as a Humboldt Research Fellow in Germany.

He served as The Director of the Indian Institute of Technology, Madras from 1995 to 2001, and as the Chairman of The All India Council for Technical Education, a statutory body of the Government of India, from 2001 to 2004.

He was the Vice President of The Indian National Academy of Engineering during 2002-2006, and the Chairman of the Research Council of the Central Fuel Research Institute, Dhanbad during 1995-2005. He is currently the Chairman of the Board for IT Education Standards of Karnataka.

He is a Fellow of: Indian National Academy of Engineering, Indian Society for Technical Education, National Academy of Social Sciences, Institution of Engineers (India), Indian Institution of Plant Engineers, National Foundation of Indian Engineers, Indian Institution of Materials Management, and Madras Science Foundation.

He has been conferred Honorary Doctorate Degrees by: The University of South Australia, Jawaharlal Nehru Technological University (A.P.), Kanpur University(U.P.), Nagarjuna University (A.P.), Purvanchal University (U.P.) and NIT, Agartala.

Dr. K. P. Isaac

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AN OVERVIEW OF THE CONTEMPORARY ISSUES IN ENGINEERING EDUCATION IN INDIA

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AN OVERVIEW OF THE CONTEMPORARY ISSUES IN ENGINEERING EDUCATION IN INDIA

CONTENTS OF PRESENTATION

- Scope of Technical Education (India)
- Why India Will be Increasingly Important in the Coming Decades
- Quantitative Trends
- How India is Focusing on Priority Areas
- Some Current Issues in Engineering Education
- Rationale For Re-design of the Engineering Education System
- Some More Contemporary Issues
- A Summary of the Features of Indian Engineering Education
Technical Education in India, as a result of the definition provided by the AICTE Act, includes, in addition to Engineering, the following:

- Management,
- Architecture,
- Pharmacy,
- Computer Applications,
- Hotel Management and Catering Technology, and
- Applied Arts and Crafts
WHY INDIA WILL BE INCREASINGLY IMPORTANT IN THE COMING DECADES
## PROJECTED RELATIVE SIZE OF ECONOMIES

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP in US$ Terms</th>
<th>GDP in PPP Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2050</td>
</tr>
<tr>
<td>USA</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>JAPAN</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>CHINA</td>
<td>18</td>
<td>94</td>
</tr>
<tr>
<td>UK</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>INDIA</td>
<td>6</td>
<td>58</td>
</tr>
</tbody>
</table>

Source: PricewaterhouseCoopers Report: *World In 2050*

By 2050, in $ terms India’s GDP will have overtaken that of UK and Japan and in PPP terms will have equalled USA.
# Working Age Population (15-59 Yrs)

**World : 100**

<table>
<thead>
<tr>
<th>Country</th>
<th>2000</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>China</td>
<td>23</td>
<td>14</td>
</tr>
<tr>
<td>USA</td>
<td>5</td>
<td>5*</td>
</tr>
<tr>
<td>West Europe</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

* USA adds significantly by its liberal immigration policy.

Source: UN World Population Prospects Database 2004

* The only country for which the number is rising is INDIA.
* In 50 years, nearly ONE IN FIVE IN THE WORLD WILL BE INDIAN
Global Success of IT entrepreneurs (Silicon Valley, for example)
Success of Indian MNCs (Tata Motors, “SWITCH” IT companies, NIIT, .....
Demographic Dividend (global workforce reservoir)
Space, Nuclear Power – exclusive global groups
## Growth of AICTE approved Technical Institutions in last six years

<table>
<thead>
<tr>
<th>Year</th>
<th>Engineering</th>
<th>Mgmt</th>
<th>MCA</th>
<th>Phar</th>
<th>Arch</th>
<th>HMCT</th>
<th>Total</th>
<th>Added in a year</th>
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</thead>
<tbody>
<tr>
<td>2006–07</td>
<td>1511</td>
<td>1132</td>
<td>1003</td>
<td>665</td>
<td>116</td>
<td>64</td>
<td>4491</td>
<td>171</td>
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<tr>
<td>2007–08</td>
<td>1668</td>
<td>1149</td>
<td>1017</td>
<td>854</td>
<td>116</td>
<td>81</td>
<td>4885</td>
<td>394</td>
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<tr>
<td>2008–09</td>
<td>2388</td>
<td>1523</td>
<td>1095</td>
<td>1021</td>
<td>116</td>
<td>87</td>
<td>6230</td>
<td>1345</td>
</tr>
<tr>
<td>2009–10</td>
<td>2972</td>
<td>1940</td>
<td>1169</td>
<td>1081</td>
<td>106</td>
<td>93</td>
<td>7361</td>
<td>1131</td>
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<tr>
<td>2010–11</td>
<td>3222</td>
<td>2262</td>
<td>1198</td>
<td>1114</td>
<td>108</td>
<td>100</td>
<td>8004</td>
<td>643</td>
</tr>
<tr>
<td>2011–12</td>
<td>3393</td>
<td>2385</td>
<td>1228</td>
<td>1137</td>
<td>116</td>
<td>102</td>
<td>8361</td>
<td>357</td>
</tr>
<tr>
<td>Year</td>
<td>Engineering</td>
<td>Mgmt</td>
<td>MCA</td>
<td>Pharm</td>
<td>Arch</td>
<td>HMCT</td>
<td>Total</td>
<td>Added In a year</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>------</td>
<td>-----</td>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
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</tr>
<tr>
<td>2006–07</td>
<td>550986</td>
<td>94704</td>
<td>56805</td>
<td>39517</td>
<td>4543</td>
<td>4242</td>
<td>750797</td>
<td>73566</td>
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<tr>
<td>2007–08</td>
<td>653290</td>
<td>121867</td>
<td>70513</td>
<td>52334</td>
<td>4543</td>
<td>5275</td>
<td>907822</td>
<td>157025</td>
</tr>
<tr>
<td>2008–09</td>
<td>841018</td>
<td>149555</td>
<td>73995</td>
<td>64211</td>
<td>4543</td>
<td>5794</td>
<td>1139116</td>
<td>231294</td>
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<tr>
<td>2009–10</td>
<td>1071896</td>
<td>179561</td>
<td>78293</td>
<td>68537</td>
<td>4133</td>
<td>6387</td>
<td>1408807</td>
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</tr>
<tr>
<td>2010–11</td>
<td>1314594</td>
<td>277811</td>
<td>87216</td>
<td>98746</td>
<td>4991</td>
<td>7393</td>
<td>1790751</td>
<td>381944</td>
</tr>
<tr>
<td>2011–12</td>
<td>1485894</td>
<td>352571</td>
<td>92216</td>
<td>102746</td>
<td>5491</td>
<td>7693</td>
<td>2046611</td>
<td>255860</td>
</tr>
</tbody>
</table>
GROWTH OF TECHNICAL INSTITUTIONS IN INDIA – YEAR WISE ADDITIONS AND GROSS NUMBER

[Line chart showing the growth of technical institutions in India year-wise.]
GROWTH OF TECHNICAL INSTITUTIONS IN INDIA – BRANCH WISE
GROWTH OF ADMISSION CAPACITY IN TECHNICAL EDUCATION IN INDIA – YEAR WISE ADDITIONS AND GROSS NUMBER
GROWTH OF ADMISSION CAPACITY IN TECHNICAL EDUCATION IN INDIA - BRANCH WISE
A QUALITATIVE ANALYSIS
# Asymmetries in Our Technical Education System

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical</td>
<td>Regions with high density of Institutions (SR, SWR, WR)</td>
<td>Regions with low density of Institutions (ER, NER)</td>
</tr>
<tr>
<td>Disciplines</td>
<td>IT related courses</td>
<td>Conventional courses</td>
</tr>
<tr>
<td>Level</td>
<td>Degree</td>
<td>Diploma</td>
</tr>
<tr>
<td>Location</td>
<td>Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>Funding and Governance</td>
<td>Government</td>
<td>Self -- financing</td>
</tr>
<tr>
<td>Exam. System</td>
<td>Affiliated</td>
<td>Autonomous, Deemed University</td>
</tr>
</tbody>
</table>
# Asymmetries in Our Technical Education System

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prospective employers</td>
<td>Large scale, corporate sector Seeking UG Experimental Research University Science and Technology Generalist Rich Information haves</td>
<td>SMEs Generating PG Computer based Teaching institution Arts and Commerce Specialist Poor Information have nots</td>
</tr>
<tr>
<td>• Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Nature of institution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Subject Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Specialization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Prosperity of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stakeholders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Access to information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EVOLUTION OF UNIVERSITY RESEARCH AND INDUSTRIAL CONSULTANCY IN INDIA

- **During the Early Years (70’s)**
  “Publish or Perish”

- **Later Years (80’s)**
  “Publish and Consult; or Perish”

- **Recent Years – post WTO**
  “Patent, then Publish; and Prosper”

- **The Open -Source Revolution**
  “Publish, Share; and Feel-Good”
OUR FOUR MAJOR CHALLENGES

- Increasing Capacity
- Improving Quality
- Enhancing Research
- Internationalizing Engineering
  Education and R &D
## HOW INDIA IS FOCUSING ON PRIORITY AREAS

<table>
<thead>
<tr>
<th>Priority Area</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant unmet demand of eligible school-leavers for entry into engg institutions.</td>
<td>Major enhancement of admission capacity in both public and private institutions</td>
</tr>
<tr>
<td>Paucity of qualified teachers</td>
<td>NPTEL Project for developing curriculum-based learning resource materials.</td>
</tr>
<tr>
<td>Paucity of Ph.D.s</td>
<td>Significant enhancement in Ph.D. admission capacity in engineering institutions and research fellowships.</td>
</tr>
<tr>
<td>Quality of engineering institutions</td>
<td>Re-design of Accreditation processes aligned with Washington Accord (and ABET) outcomes – based criteria.</td>
</tr>
</tbody>
</table>
President’s Address to the Parliament on June 4, 2009

“My Government will ensure that its policies for Education and S&T are infused with a spirit of innovation, so that the creativity of a billion people is unleashed.

The next ten years would be dedicated as a Decade of Innovation”

National Innovation Council established under the chairmanship of Sam Pitroda.
SOME CURRENT ISSUES IN ENGINEERING EDUCATION

- The (generation gap) between:
  - those who teach and those who learn
  - those who recruit and those who seek jobs
  - those who frame policies and those who function within the system
  - theory and practice of assessment of:
    learning, and of performance on the job
- How do we close these gaps?
AUTONOMY

- Whom to teach – Students
- What to teach – Curriculum
- Who will teach – Faculty
- How to assess – Exams

- Academic
- Administrative – Managerial
- Financial
- Functional
### DIFFERENT COMBINATIONS OF BUZZWORDS IN HIGHER EDUCATION

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellence</td>
<td>Affordability</td>
</tr>
<tr>
<td>Diversity</td>
<td>Sustainable Development</td>
</tr>
<tr>
<td>Employability</td>
<td>Relevance</td>
</tr>
<tr>
<td>Global Engineer</td>
<td>Innovation</td>
</tr>
<tr>
<td>Glocal</td>
<td>Quality</td>
</tr>
</tbody>
</table>
A CHANGING WORLD

Worldwide changes
- Changes in technology
- Changes in education and training
- Changes to work and professions
- Changes in management and organisation of institutions
<table>
<thead>
<tr>
<th>Sector</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy</td>
<td>❖ Favorable trading opportunities</td>
<td>❖ deregulation</td>
</tr>
<tr>
<td></td>
<td>❖ expanded markets</td>
<td>❖ enhanced privatization</td>
</tr>
<tr>
<td></td>
<td>❖ expanded markets</td>
<td>❖ currency integration</td>
</tr>
<tr>
<td>Education</td>
<td>❖ Enhanced markets for educational products, processes and services</td>
<td>❖ study opportunities abroad for those who can afford it</td>
</tr>
<tr>
<td></td>
<td>❖ making up for reduced indigenous demand</td>
<td>❖ Competition to local institutions</td>
</tr>
<tr>
<td>Employment</td>
<td>❖ leads to erosion of jobs</td>
<td>❖ leads to off-shore jobs</td>
</tr>
<tr>
<td></td>
<td>❖ competition from low-wage work force from LDCs</td>
<td>❖ opportunities for short-term employment abroad</td>
</tr>
</tbody>
</table>
## SWOT ANALYSIS OF A TRADITIONAL ENGINEER

### STRENGTHS
- Analytical Capabilities
- Design Capabilities -
  - ability to handle open-ended problems
  - ability to handle poorly-defined problems
  - creativity and innovation
- Decision-making, including problem-solving
- Graphical communication skills
- Discipline, Work ethic.

### WEAKNESSES
- Ability to work in a Team
- Inter-disciplinary knowledge
- Practical orientation (academics)
- Commercial orientation
- Introspective nature, modesty
- Oral and written communication skills
- Integrative skills
- Ability to employ IT
- Obsolescence (remedy: Continuing Education)
- Inter-personal skills
- Public perception and recognition

### OPPORTUNITIES
- Most real-life problems require contributions from Engineers
- National policies recognize role of S & T
- Business recognizes role of Technology
- Ambition of bright youth to become Engineers
- Globalisation offers opportunities for acquisition of state-of-the-art technologies

### THREATS
- Competition from Scientists, Economists, Financial Experts, Administrators in high-level decision-making bodies.
- Quantitative expansion in Technical Education without simultaneous Quality assurance
- Industrial development entails depletion of natural resources and environment degradation -- Engineers held responsible for these.
A COMPARISON OF THE TRADITIONAL AND XXI CENTURY ATTRIBUTES OF ENGINEERS

<table>
<thead>
<tr>
<th>TRADITIONAL ATTRIBUTES</th>
<th>XXI CENTURY ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>❖ Problem-solving abilities</td>
<td>❖ Learnability: learning to learn, on one's own</td>
</tr>
<tr>
<td>❖ Analytical skills</td>
<td>❖ Yen for life-long learning — continuous education</td>
</tr>
<tr>
<td>❖ Communication skills —</td>
<td>❖ Ability to muster knowledge from neighboring disciplines</td>
</tr>
<tr>
<td>▪ Oral, written, graphic</td>
<td>❖ Ability to work in a team</td>
</tr>
<tr>
<td>❖ Ability to relate to practical aspects of engineering</td>
<td>❖ Exposure to commercial disciplines</td>
</tr>
<tr>
<td>❖ Inter-personal skills</td>
<td>❖ Creativity and Innovation</td>
</tr>
<tr>
<td>❖ Management skills</td>
<td>❖ Integrative skills</td>
</tr>
<tr>
<td>❖ Decision-making skills</td>
<td>❖ International outlook</td>
</tr>
<tr>
<td>❖ Design capabilities</td>
<td>❖ Ability to employ IT</td>
</tr>
<tr>
<td>▪ ability to handle open-ended problems</td>
<td>❖ Ability to work at interfaces between traditional disciplines</td>
</tr>
<tr>
<td>▪ ability to handle poorly-defined problems</td>
<td>❖ Commitment to sustainable development</td>
</tr>
<tr>
<td>❖ Discipline, work ethic</td>
<td></td>
</tr>
</tbody>
</table>
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

- ENVIRONMENT, AMBIENCE
  - Significant Impact of Technology on:
    Education, Industry, Commerce, Lifestyle, Entertainment, Society
  - Demand for Mass Education
  - Widening of Disparities:
    - Technology Divide
    - Digital Divide
    - Prosperity Divide
    - Literacy/Education Divide
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

❖ Increased Uncertainty, Lowered Predictability

❖ Importance of Institute-Industry Interaction

❖ Potential of ET and ICT for enhancing the effectiveness of Learning

❖ Distance Education / Virtual University Initiatives
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

- Changing Employer – Employee Loyalty Relationships:
  Implications of:
  • Lifetime employment
  • Outsourcing
  • Down / Right-sizing
  • Hire and Fire

- Quality Assurance and Accreditation
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

• Significant Changes in the Practice of Engineering as a Profession in the new millennium:
  • Constraints imposed by environmental considerations
  • Customization demanded by diverse customers
  • Opportunities offered by technology developments in several sectors
  • Availability of sophisticated diagnostic and computational tools
  • Wide choice of materials
  • Implications of Globalization, such as, for example, Innovation as the basis of Competitiveness
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

- Changing and Emerging Roles of:
  - Leadership, Governance
  - Faculty: Teaching, Mentoring, Assessment
  - Support Services

- Redefined Goals of Technical Education:
  - Quality, Excellence, World-Class
  - International Competitiveness
  - National Relevance
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

- Redefined Goals of Technical Education (cont’d):
  - Appropriate Technical Education
  - Identification of Stakeholders, and Fulfillment of their Requirements
  - Emerging Demands of the Profession
  - Professional Ethics and Human Values
  - Social and Societal Responsibility
  - Sustainable Development
  - Environmental and Ecological Responsibility
  - Resource Conservation
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

- **Perspective Planning:**
  - Manpower Development
  - Discipline-wise distribution
  - Regional distribution
  - Level-wise distribution: Degree / Diploma
  - Ph.D and P.G. programs
  - Emerging Thrust Areas
RATIONALE FOR RE-DESIGN OF THE ENGINEERING EDUCATION SYSTEM

**Emerging Models:**

- Technological Universities
- Deemed Universities
- Virtual Universities / Distance Education
- Autonomous vs Affiliated Institutions
- Twinning arrangements with foreign institutions
- "Brick", "Click" & "Hybrid" Models.
SOME MORE CONTEMPORARY ISSUES

I. Which Stakeholder should dictate our System?

- Student
- Employer / Recruiter
- Institution
- Faculty
II Conflicts:

• Short-range perspective of Employers vs. Long-range perspectives of Academics
• Soft skills demands of Employers vs. Hard skills focus of Academics.
  - A person with hard skills, but no soft skills:
    - 'Nerd', not a Leader
  - A person with soft skills, but no hard skills:
    - Bluff-master, gas-bag
• Institution's perception of a Faculty member as a Commodity, a 9-5 worker; a commodity which can be purchased in the market.
III  *Internal Brain Drain* (criticized)

- Students given professional education (Engineering, e.g.) taking up careers un-related to their education and training
- Particularly, Marketing, Advertising, Finance attract criticism.
- We have learned to accept *External Brain Drain*:
  - Brain Gain, Brain Circulation
  - The Success of the Silicon Valley Entrepreneurs
  - Offshore jobs from India
  - Alumni support to their Alma Maters
THE SYMBIOTIC AND SYNERGISTIC RELATIONSHIP BETWEEN UNIVERSITY AND INDUSTRY

• University is the intermediary between two important Stakeholders:  
  ☒ Students  
  ☰ Employers

• We need bridges between Engineers in University and Industry through committed Educators, Researchers and Professionals.

• The two Partners need and depend on each other, and derive mutual benefit from the partnership – Symbiosis.

• The overall impact can be much greater when the two partners function in phase and in resonance – Synergy.

• It is necessary to create a win-win partnership for both partners.
Our Technical Education System is characterized by
• Huge size
• Many Asymmetries and Divides
• Diversity (of many types)
• Variable Quality
• Frequent changes of Policy
• Many International Collaborations
• Many Strengths and Weaknesses
• Many Opportunities and Challenges