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
AN OVERVIEW OF THE CONTEMPORARY ISSUES IN ENGINEERING EDUCATION IN INDIA

Prof R Natarajan
Former Chairman, All India Council for Technical Education
Former Director, Indian Institute of Technology, Madras
prof.rnatarajan@gmail.com
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)

Source: UN World Population Prospects Database 2004

<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
ADVANTAGE INDIA – SOME EXAMPLES

➢ 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
QUANTITATIVE TRENDS
## 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>
</tr>
</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>
</tr>
<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>
</tr>
<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>
</tbody>
</table>
## Growth of intake in AICTE approved Institutions in last six years

<table>
<thead>
<tr>
<th>Year</th>
<th>Engineering</th>
<th>Mgmt</th>
<th>MCA</th>
<th>Pharm</th>
<th>Arch</th>
<th>HMCT</th>
<th>Total</th>
<th>Added In a year</th>
</tr>
</thead>
<tbody>
<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>
</tr>
<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>
</tr>
<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>
<td>269691</td>
</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>
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<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

![Graph showing growth of technical institutions in India over years]

- Total
- Added in Year

Year: 2005-06 to 2010-11

Gross number of technical institutions in India increased significantly from 2005-06 to 2010-11, with a notable rise in the total number and a fluctuation in the number added in each year.
GROWTH OF TECHNICAL INSTITUTIONS IN INDIA – BRANCH WISE

![Graph]

- Engineering
- Management
- MCA
- Pharmacy
- Architecture
- HMCT

**Year**
- 2005-06
- 2006-07
- 2007-08
- 2008-09
- 2009-10
- 2010-11
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

![Graph showing growth of admission capacity in technical education in India by branch wise. The graph illustrates the increase in engineering, management, MCA, pharmacy, architecture, and HMCT across the years 2005-06 to 2010-11.]}
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</td>
<td>SMEs</td>
</tr>
<tr>
<td>Employment</td>
<td>Seeking UG</td>
<td>Generating PG</td>
</tr>
<tr>
<td>Level</td>
<td>Experimental Research University</td>
<td>Computer based</td>
</tr>
<tr>
<td>Research</td>
<td>Science and Technology</td>
<td>Teaching institution</td>
</tr>
<tr>
<td>Nature of institution</td>
<td>Generalist Rich Information haves</td>
<td>Arts and Commerce</td>
</tr>
<tr>
<td>Subject Areas</td>
<td>Information haves</td>
<td>Specialist Poor</td>
</tr>
<tr>
<td>Specialization</td>
<td>Rich Information have nots</td>
<td></td>
</tr>
<tr>
<td>Prosperity of Stakeholders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access 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 FOCUSSING ON PRIORITY AREAS

1. Significant unmet demand of eligible school-leavers for entry into engg institutions.
2. Paucity of qualified teachers
3. Paucity of Ph.D.s
4. Quality of engineering institutions

1. Major enhancement of admission capacity in both public and private institutions
2. NPTEL Project for developing curriculum-based learning resource materials.
3. Significant enhancement in Ph.D. admission capacity in engineering institutions and research fellowships.
4. Re-design of Accreditation processes aligned with Washington Accord (and ABET) outcomes – based criteria.
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.
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

- Inclusion
- Excellence
- Diversity
- Employability
- Global Engineer
- Glocal
- Expansion
- Affordability
- Sustainable Development
- Relevance
- Innovation
- Quality
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
## GLOBALISATION--DIFFERENCES IN PERCEPTIONS OF DCs AND LDCs

<table>
<thead>
<tr>
<th>Sector</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
</tr>
</thead>
</table>
| Economy    | ❖ Favorable trading opportunities  
             ❖ expanded markets                                                                  | ❖ deregulation  
             ❖ enhanced privatization  
             ❖ currency integration                                                          |
| Education  | ❖ Enhanced markets for educational products, processes and services  
             ❖ making up for reduced indigenous demand                                          | ❖ study opportunities abroad  
             ❖ Competition to local institutions                                               |
| Employment | ❖ leads to erosion of jobs  
             ❖ competition from low-wage work force from LDCs                                    | ❖ leads to off-shore jobs  
             ❖ opportunities for short-term employment abroad                                 |
### SWOT ANALYSIS OF A TRADITIONAL ENGINEER

<table>
<thead>
<tr>
<th><strong>STRENGTHS</strong></th>
<th><strong>WEAKNESSES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ Analytical Capabilities</td>
<td>☑ Ability to work in a Team</td>
</tr>
<tr>
<td>☑ Design Capabilities --</td>
<td>☑ Inter-disciplinary knowledge</td>
</tr>
<tr>
<td>☑ ability to handle open-ended problems</td>
<td>☑ Practical orientation (academics)</td>
</tr>
<tr>
<td>☑ ability to handle poorly-defined problems</td>
<td>☑ Commercial orientation</td>
</tr>
<tr>
<td>☑ creativity and innovation</td>
<td>☑ Introspective nature, modesty</td>
</tr>
<tr>
<td>☑ Decision-making, including problem-solving</td>
<td>☑ Oral and written communication skills</td>
</tr>
<tr>
<td>☑ Graphical communication skills</td>
<td>☑ Integrative skills</td>
</tr>
<tr>
<td>☑ Discipline, Work ethic.</td>
<td>☑ Ability to employ IT</td>
</tr>
<tr>
<td></td>
<td>☑ Obsolescence (remedy: Continuing Education)</td>
</tr>
<tr>
<td></td>
<td>☑ Inter-personal skills</td>
</tr>
<tr>
<td></td>
<td>☑ Public perception and recognition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>OPPORTUNITIES</strong></th>
<th><strong>THREATS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ Most real-life problems require contributions from Engineers</td>
<td>☑ Competition from Scientists, Economists, Financial Experts, Administrators in high-level decision-making bodies.</td>
</tr>
<tr>
<td>☑ National policies recognize role of S &amp; T</td>
<td>☑ Quantitative expansion in Technical Education without simultaneous Quality assurance</td>
</tr>
<tr>
<td>☑ Business recognizes role of Technology</td>
<td>☑ Industrial development entails depletion of natural resources and environment degradation -- Engineers held responsible for these.</td>
</tr>
<tr>
<td>☑ Ambition of bright youth to become Engineers</td>
<td></td>
</tr>
<tr>
<td>☑ Globalisation offers opportunities for acquisition of state-of-the-art technologies</td>
<td></td>
</tr>
</tbody>
</table>
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>✤ <strong>Learnability</strong>: 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 — ▪ Oral, written, graphic</td>
<td>✤ Ability to muster knowledge from neighboring disciplines</td>
</tr>
<tr>
<td>✤ Ability to relate to practical aspects of engineering</td>
<td>✤ Ability to work in a team</td>
</tr>
<tr>
<td>✤ Inter-personal skills</td>
<td>✤ Exposure to commercial disciplines</td>
</tr>
<tr>
<td>✤ Management skills</td>
<td>✤ Creativity and Innovation</td>
</tr>
<tr>
<td>✤ Decision-making skills</td>
<td>✤ Integrative skills</td>
</tr>
<tr>
<td>✤ Design capabilities — ▪ ability to handle open-ended problems</td>
<td>✤ International outlook</td>
</tr>
<tr>
<td>▪ ability to handle poorly-defined problems</td>
<td>✤ Ability to employ IT</td>
</tr>
<tr>
<td>✤ Discipline, work ethic</td>
<td>✤ Ability to work at interfaces between traditional disciplines</td>
</tr>
<tr>
<td></td>
<td>✤ Commitment to sustainable development</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
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.
A SUMMARY OF THE FEATURES OF INDIAN ENGINEERING EDUCATION

- 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