Science & Technology
Creativity and Inventions

National Academy of Sciences
Science Day, February 28, 2010

Ashok Misra
Chairman-India, Intellectual Ventures
Former Director, IIT Bombay
ashokmisra@intven.com
Science Day in India

Sir C.V. Raman worked on the Molecular Scattering of Light. It was on February 28th, 1928 that announced the discovery of what was subsequently known as the “Raman Effect” for which he received the Nobel Prize two years later. He thus became the first scientist from India to get the Nobel Prize – a feat that has not been repeated since then.
Importance of Science

“\textit{It is science and science alone that could solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.}”

\textit{Pundit Jawaharlal Nehru in “Discovery of India”}
Importance of Science in India

- Science is the base for the development of all technological and economic growth. Advancing nations have to be strong in Science.
- It is imperative we in India emphasize the importance of Science.
- Ensure that our bright youngsters are attracted to science subjects.
- This will enhance the level of science education and research.
- We produce approx. 50 lakhs students at the 12th class level – greater than the population of several nations.
- Yet in India there is large shortage of good scientists in all the research laboratories.
- System should provide ample opportunities of creativity, innovation and generation of new ideas at all levels of science education.
Globalization and the Knowledge Economy

- The advances in technology have led to globalization and increased the power of knowledge.
- New and specialized knowledge spreads globally faster than capital or people.
- When this dissemination occurs, the entire world and mankind stand to gain.
- The creation of specialized knowledge is where the Inventors and Innovators come in.
- Science base of the country has to be very strong.
- Inventions are Global – key to economic growth.
Through Pandit Nehru’s Vision

- The Indian Institutes of Technologies were set up
- Tata Institute of Fundamental Research started
- Bhabha Atomic Research Centre established
- Indian Institute of Science received a further boost
- Council for Scientific & Industrial Research – set up several labs
- Department of Science & Technology

These initiatives led to the growth of Science & Technology and Education & Research in India
Indian Scientists who made a Difference

- C. V. Raman – Physics – Nobel Prize
- Meghnad Saha – Physics
- Jagdish Chandra Bose – Physics & Botany
- S. Chandrashekhar – Astrophysics
- Srinivasa Ramanujan – Mathematics
- Satyendra N. Bose – Physics
- Praful Chandra Ray – Chemistry
- Neel Ratan Dhar – Chemistry & Agriculture
- P.C. Mahalanbhis – Mathematics
- Birbal Sahni – Botany

All of them worked at times when sophisticated instruments and powerful computational tools and unimaginable informational technology was not available.
Scientists & Engineers who have made a Difference in India

- Homi J. Bhabha – Department of Atomic Energy
- S.A. Vikram Sarabhai – Department of Space
- M.G.K. Menon – Established the Department of Electronics, Space and several others.
- Satish Dhawan – Department of Space and IISc
- A.P.J. Abdul Kalam – ISRO and DRDO – missile programme
- C.N.R. Rao – Chemistry & Materials Science. Set up JNCASR
- K. Kasturirangan – Department of Space (ISRO)
- M. Visvesvaraya – Civil Engineering
- MM Sharma – Chemical Engineering
- R. Chidambaram – Atomic Energy
- Anil Kakodkar – Atomic Energy
Scientists who changed our lives

Isaac Newton – Gravity
(1687)

Alexander Graham Bell – Telephone
(1876)

Jagdish Chandra Bose - Father of Radio Science
(1894)
Scientists who changed our lives

Madame Curie
Radium (1898)

John Logie Baird
Television (1925)

Alexander Fleming
Penicillin (1928)
Scientists who changed our lives

CV Raman – Molecular Scattering of Light (1930)

John Enders
Polio Vaccine (1948)

Martin Cooper
Mobile Phone (1973)
People who have continued to...

- Robert Noyce – The integrated circuit
- Bill Gates – First ubiquitous operation system after the human brain
- James Watson – DNA structure
- Sanjai Kohli – Architect of mass-market GPS
- Craig Venter – Genome sequencing (and more?)
- Robert Langer – Drug delivery
- Steve Jobs – “A lot of times, people don’t know what they want until you show it to them.”
Role of Institutions of Higher Learning

- Education
  - to develop high quality manpower

- Basic research and development
  - to create new knowledge

- Applied research and development
  - to use that new knowledge to develop intellectual property, inventions and advanced technologies
The Golden Age of Invention

- Camera
- Movie
- Radio
- Light bulb
- Surgery
- Automobile
- Airplane
- Phone
- Vaccine
- X-ray
- Laser
- Medical devices
- Integrated circuit
- Network connectivity
- Television

- 100 year old products are suddenly changing
- Still driven by new discoveries in science
- Higher risk and diversity but good for mankind
- Break traditional boundaries
The Golden Age of Invention
The Golden Age of Invention
The Earth Needs Inventions

• Addressing the digital divide
• Food and resource management
• Energy generation and distribution
• Healthcare
• Waste management
• Ecological balance
• Counter-terrorism
• A vaccine is a biological preparation that improves immunity to a particular disease.
• Began as "variolation“, i.e. exposing uninfected individuals to matter from smallpox lesions. Now more scientific.
• Vaccine technology has wiped out major diseases, but newer ones are still needed.
Digital signal-processing techniques, originally developed to enhance pictures of the Moon for the Apollo Program, are an indispensable part of Computer-Aided Tomography (CAT) scan & Magnetic Resonance Imaging (MRI) technologies used today worldwide.
Monitoring of cardiac patients with state-of-the-art electronics, embedded into an ultra small form factor - thus named ‘locket’. To accelerate modern treatment.
Artificial Hand

- Low cost motorised hand with finger grasp & forearm rotation
- Patient interfaces
  - Myoelectonics control
  - Ultrasound whistle
  - Mechanical switches
- Patient trials
  - All India Institute for Physical Medicines & Rehabilitation
  - Christian Medical College, Vellore
R&D Indian Aerospace Programmes
ENERGY — INPUTS NEEDED

- Coal gasification technology – Thermal power
  - Plant efficiency improvements
  - Cleaner processing

- Solar power – working towards grid parity and meeting the NSM 20 GW goal by 2020
  - Solar PV cell / module / BOS efficiency improvements
  - Solar thermal concentrator technologies

- Power utilization efficiency
  - Centralized power transmission – loss reduction
  - Energy-efficient materials of building construction
  - Fuel-efficiency – Automobiles / heavy machinery / pumps
WATER — INPUTS NEEDED

• Cost-effective desalination technologies
• Low-cost point-of-use filtration systems (Tata’s Svach)
• Technologies to reduce use
  • e.g., Elimination of water in dyeing processes
• Technologies to recycle water efficiently
  • Rain Water Harvesting – standardization of methods / materials
    optimization by geography / climate / soil type
  • Ground water remediation
  • Grey water recycling
India Needs Inventions – FOOD

FOOD STORAGE

NOURISHMENT

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Watershed Events in the History of Communications Technology

• The events:
  – The invention of the telegraph/telephone: Late 19th/early 20th century
  – The invention of the radio and television: Mid-20th century
  – The internet revolution: Late 20th/early 21st century

• The expectations:
  – A more interconnected world, with synergies of cross-pollination
  – Improved opportunities with increased access to information
  – Higher life-expectancy and quality of life, with improved access to medical expertise
  – Potentially greater governmental accountability and transparency

Reference: Kenneth Keniston, MIT
Polymerization is one of the biggest contributions of Chemistry in the 20th century. It facilitated the conversion of a large number of small molecules to form long chain molecules – Polymers. The variety of materials possible in the family of Polymers is really very large. Polymers can be modified for attaining properties for specific end application.
<table>
<thead>
<tr>
<th>Year</th>
<th>Laureate</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>Paul J. Flory</td>
<td>For fundamental achievements, both theoretical and experimental, in physical chemistry of macromolecules.</td>
</tr>
<tr>
<td>1963</td>
<td>Karl Ziegler</td>
<td>For their discoveries in the field of chemistry and technology of high polymers.</td>
</tr>
<tr>
<td></td>
<td>Giulio Natta</td>
<td></td>
</tr>
<tr>
<td>1953</td>
<td>Hermann Staudinger</td>
<td>For his discoveries in the field of macromolecular chemistry.</td>
</tr>
</tbody>
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Polymeric Materials

Various types – wide spectrum

- Rubbery polymers – soft and flexible
- Glassy polymers – hard and rigid
- Polymers that can be oriented – Fibre and applications
- Very strong polymers
- Very tough polymers
- Polymers with low coefficient of friction
- Polymers with special properties
The Reality of the Digital Divide

Many are being left behind, for a variety of reasons, including:

- Strong correlation between access to information and financial well-being – the poor are left behind, worldwide
- Further, the information access gap perpetuates a vicious cycle
- The predominant language of the internet is English – do not speak it, and the information ‘at your disposal’ is actually not

Reference: (1) Kenneth Keniston, MIT; (2) International Telecommunication Union
The Reality of the Digital Divide

Internet users per 100 inhabitants 1997-2007 (Source: ITU)

Reference: (1) Kenneth Keniston, MIT; (2) International Telecommunication Union

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Unique Identification Number

- World’s largest data base management project
- Aims to give UID nos. to 600 m people by 2014
- To provide a 12 digit number. For this need to:
  - Take 600 m photographs
  - Check 600 m addresses
  - Scan 1.2 b irises
  - Collect 6 b finger prints
- For the 600 millionth person – check for duplication
  - Compare with (600 m – 1) photographs & addresses
  - Compare with (1.2 b – 2) irises
  - Compare with (6 b – 10) finger prints
80% of the Internet text in English

Need to build bridge between languages through computer (UNL)

UNL – An intermediate language form into or from which other languages can be converted or generated

18 major countries participating in UN initiated UNL project

Hindi is one of the 18 selected languages for international linking

IIT Bombay the India representative for enabling Hindi
Media Lab Asia Projects at IIT Bombay

Polysensors
Sensors for water quality assessment

Interfaces for All

Interlingua on web: Agro Explorer

aAQUA

Speech Interfaces

Devanagari Text Input

Content Development Tools

Bhav Puchiye
Online expert Question & Answers based community forum for delivering information to the grass-roots of Indian Community.

Multilingual communication framework

- To provide a language independent knowledge database

- To provide an easy to use interface to accommodate even inexperienced users

- To integrate on-line and off-line expertise
EMU Farming
I intend to Start EMU Farming and such need the address Contact telephone of - Bhagirathi Hatche...

Jun 14, 10:24 AM
baramati

Jersey and Hallstone cow farming
Sir, I am interested to know about the feasibility in setting up a cow farm with above varieties of c...

Jun 13, 6:42 PM
kiranmodi

Mung Cultivation
how to cultivate the mung (Green gram) for higher yield. thanks

Jun 13, 3:45 PM
pramod_pochhi

Sheed size for 100 goats
Respected sir, I am Firoz Nazir from Raigard tal Mahsala village Mendadi sir, I want to start a ...

Jun 13, 3:34 PM
baramati

Question on Land purchase
Hi, i want to buy a Banglow plot in Owner has all the legal Documents, but the markng for plot has ...

Jun 13, 3:19 PM
baramati
Developments in new materials and product design are offering surgeons and patients new options for joint replacement surgery.
Gore-Tex — Special Fabric

Exterior
- Transpiration
- Abrasion resistant outer shell
- Protection

Interior
- Transpiration
- Gore-Tex membrane
- Protection
- Soft inner liner
Water-Jet Cutting Machine

Can cut steel, brass, aluminum and wood
Design of Post Box — IIT Bombay

Attractive Design
Stainless Steel body, large space for Ads.

Convenient rest for posting

Strong and Durable
Common key to open
Tough Composite top
Easy Time slider
Invention Drive Train

An Engine is not enough
Innovation vs. Invention

- Not easily definable – simply put:
  - *Invention* is – a foray into the unknown
  - *Innovation* is – putting together the known for novel effect

- Most of us innovate – a few of us invent

- We innovate on the move – but unless action follows the process is not complete
Who is an Inventor?

- RESEARCHER
- FACULTY MEMBER
- STUDENT
- ENTREPRENEUR
- EMPLOYEE
- INDEPENDENT CONSULTANT
What makes a good Invention?

- An act or instance of creating or producing by exercise of the imagination a technical innovation
- Protectable
- Intellectual in Origin
- Inevitable Context
- Beyond the obvious

Good inventions can come from anywhere
Invention is the Source of Value

• All technologies begins with inventions
• All Invention begin with **Science**
• Inventions drive technology markets
• But inventions are sometimes neglected…
• Investment in invention can be systematic, not just serendipitous
A Growth of 950% in 150 years
Innovation was an will be the key!
India’s IP Trade Deficit (1995 – 2005)

$3.7 billion

less (-) $410 million

payment of royalties & license fees

receipt of royalties & license fees

$3.3 billion
Inventions Drive Technology

• All technology begins with invention

• Invention drives technology markets
  – Communications
    • Telegraph, telephone, cellular, internet
  – Information Technology
    • Computing, semiconductors, software
  – Biology
    • Vaccines, Bio-medical devices, Diagnostics

ENORMOUS SOCIO-ECONOMIC BENEFITS
The Traditional Path

1. Extraction of natural resources
2. Heavy industry
3. Low-value mfg. and assembly
4. Low-value services
5. Innovation and high-value services
A Technological Shortcut
Extraction of INTELLECTUAL resources

Inventions

Innovation and high-value services
CReating an IPR Environment

• To sustain and grow creative ideas in an ethical environment and

• Assist in translating these ideas into products, processes & services

This requires an appreciation for and an awareness of Intellectual Property-related issues
Institutes of Higher Learning

Ambience for Creativity and Innovation

Generation of New Knowledge

New Ideas leading to Inventions

Intellectual Property Rights

For Public Good and Wealth Creation
Technology Incubation
From Concept to Deployment

- Technology Development
- Prototype Demonstrator
- Manufacturing
- Sales and Marketing
- Deployment
- R & D

Technology Incubation → Company Creation → VC: Wealth Generation

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Aims & Objectives

- To encourage the development of a scientific temper among students.
- To promote a mutually fruitful interaction between the academic community and the industry.
- To explore the impact of technology on human society.
Continuous Innovation Is The Key!

Graph Courtesy NanoHUB/OpenScienceGrid.org

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For coming up with new ideas you don’t have to Think Linearly!
Science and Creativity

“Concern for man and his destiny must always be the chief interest of all technical efforts. Never forget it in all your dreams and equations.”

Albert Einstein

“Science is People.”

Prof. Alan MacDiarmid
Nobel Prize (Chemistry), 2000

“If you want to understand the future, create it.”

- Peter Drucker
INVENT IN INDIA...

INVENT FOR THE WORLD!

IGNITE A MILLION MINDS!