Indian Science, Technology and Innovation:

The Changing Landscape

R A Mashelkar



"It is an inherent obligation of a great country like India with its traditions of scholarship and original thinking and its great cultural heritage to participate fully in the march of science, which is probably mankind's greatest enterprise today."

- Jawaharlal Nehru



Homi Bhabha, Vikram Sarabhai, S S Bhatnagar





INSTITUTION BUILDERS

Green Revolution (Agriculture) White Revolution (Milk)

Many Revolutions Spurred by Indian S&T

Blue Revolution (Space)

Gray Revolution (Software)

Crops	India's world Rank in production
Pulses	1
Milk	1
Arable Land	2
Wheat	2
Rice	2
Sugar cane	2
Cotton	2
Vegetables & melons	2
Fruits excluding melons	2
Теа	2
Potato	3
Oilseeds	5

The Challenge

High in Production but low in Productivity

No 1 in pulse production but a large importer of pulses!

 Moving from 'Green' to 'Evergreen'& 'Nutritional' Revolution

Embracing new technology

 India second largest producer and exporter of cotton

•BT cotton introduced in 2002

- •150-fold increase in 2008
- •81 % of total cotton area under BT cotton now

•95% Value Added over non BT

•80% higher profits to the farmers



Bt Cotton



THE STORY UNDERNEATH

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India's Mission to the Moon (2008)

Chandrayan 1 Carrying 2 US Payloads from NASA!







Technology Led Inclusive Growth for Fishermen



- 7 million people on the coast depend on fishing for livelihood
- Satellite based Potential Fishing Zone forecasts helps in deep sea fishing
- More than 225 nodes receive forecasts
- Substantial increase in fishermen income

Top Ten Achievements of the 20th Century Jayant Narlikar (2003), The Scientific Edge, Penguin

- S. Ramanujam- Mathematics (20s)
- Meghnad Saha- Ionization Equation (20s)
- S.N Bose- Particle Statistics (1922)
- C.V. Raman- Raman Effect (1928)
- G.N. Ramachandran- Molecular Biophysics (mid 50s)
- Nuclear Power (50s)
- Green Revolution (70s)
- Space Programme (late 70s)
- Superconductivity (late 80s)
- CSIR Transformation (late 90s)



Indian Grand Challenges

Balancing Expansion, Inclusion, Excellence

Spurring Industrial R&D

Inclusive Innovation

Expansion

 No growth in enrolment in post school education between 1900-1947

Gross higher education enrolment ratio is 11.5% (global average- 26%)

Need for more Universities

Country	Population (mn)	No of Universities	No of Univ India should have to be at par
Korea	45	120	2930
UK	50	170	3740
USA	300	1800	6600
India	1100	440	-

Current Expansion

- 30 Central Universities
- 5 Indian Institutes of Science Education and Research
- 8 Indian Institute of Technology (IIT)
- 7 Indian Institute of Management (IIM)
- 20 Indian Institute of Information Technology
- 1600 Polytechnics
- 10000 Vocational Schools
- 50000 Skills Development Centres

Hindustan Times July 06, 2006

In science, too many seats but not many takers

VANITA Chitkara and NOVITA Singh New Delhi, July 5

AT THIS rate, colleges may stop of-

INSPIRE: Innovative Initiative



Innovation in Science Pursuit for Inspired Research

Science and Innovation Scholarship to One Million people Attract talent to Science at an early stage Commitment for 20 years

Exclusion due to:

Poverty

Illiteracy

Gender

Distance



Grand Challenges

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India's 3 Freedoms

First Freedom- 1947
 Political

Second Freedom- 1991
 Trade and Economic

Third Freedom- 2008 Technological?

Second Freedom (1991) Let the customer have any colour of the car as long as it is black

Henry Ford

Let the customer have any car as long as it is Ambassador/Fiat Indian Government (Pre 1991)

Second Freedom (1991)

Indica to Indigo

If Telco had been allowed to develop as it should have been, I have no doubt we'd be making cars in India. And a Tata car would have been dominant as the Tata truck is today JRD Tata Feb 1978

Wheel Turns the Full Circle

1950s British Morris Oxford

Indian Ambassador

50 years later Indian Indica



City Rover

And Spiraling Up....



market game.

Win fabulous prizes.

THE ECONOMIC TIMES



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 Energy
 Ind'l Goods
 Svs
 Healthcare

Jaguar-Land Rover to soon run on Tata Motors engineering

1 Jun 2010, 0418 hrs IST,MV Ramsurya & Liiee Philip,ET Bureau

Health Insurance- 50 Lacs Health Insurance policy that provides cover upto 50 lacs. MaxBupa.in/Health_Insurance_50_Lacs

Ads by Google

Corporate Innovation Movement

Drugs and Pharmaceutical Industry



Copying Molecules

То

Creating Molecules

India can do it!!

Indian Tuberculosis Breakthrough

- Discovery of a new drug molecule, first in last 40 years
- Reduces treatment duration from 6 months to 2 months (in combination)
- In phase II clinical trial

And many more in the offing...





Science \longrightarrow Technology \longrightarrow Innovation

1984- USD 250 and a garage

2004 – IPO oversubscribed 33 times. Crosses USD 1 billion mark on the first day of listing.

Today she is the richest woman in India!! Among World's 100 Most Powerful Women - Forbes 2008







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United Sta Sivaram ,	ites Patent et al.	
Preparatio	n of polycarbonates with bioxyanion catalyst	
	Abstract	
The inventio carbonate a having the g `R` represer	n discloses an improved process for the preparation of aryl polycarl nd dihydric phenol in the melt phase with a catalyst belonging to the eneral formula: ##STR1## Wherein `X` represents a carboxylate or hts alkyl or aryl.	ponates. The process involves reacting aryl class of quaternary ammonium bioxyanions a phenolate group or a mixture thereof and
Inventors:	Sivaram; Swaminathan (Maharashtra, IN); Sehra; Jagdish C. (Maharashtra, IN); Shardwai; Jakwar S. (Gujarat, IN); Satish; S	(Maharashtra, IN); Iyer; Venkat S. Shee (Guiarat IN)
Assignee	Council of Scientific & Industrial Research (New Delhi IN)	
Appl. No.:	865951	
Filed:	April 9, 1992	
Current U.	.S. Class:	528/199 : 528/196: 528/198



Intern'l Class:

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528/199; 528/196; 528/198

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United States Patent... 😑 csir (E:)

India is a developing country but it is a developed country as far as its intellectual infrastructure is concerned. We get the highest Stortin F. Westen Technology Cent intellectual capital per dollar here.

> John Welch CEO, GE 17 Sept 2000



Scientific publications

Country	SCI Publications (1997-2001)	GDP per Capita	SCI Publications per GDP per Capita/ per year
India	77201	487	32
China	115339	989	23
United States	1265808	36006	7
Germany	318286	24051	3
United Kingdom	342535	26445	3
Japan	336858	31407	2
Canada	166216	22777	1
Italy	147023	20528	1
Korea, Rep.	55739	10006	1
France	232058 Basic source: D	240461 avid King, Nat	.2 Ture, July 2004

MNC R&D Centers in India



□ 780 MNC R&D centers

 281 of the global 1,000 mega R&D spenders have centers in India

□ 1,60,000 scientists work at MNC R&D centers.

The Tide beginning to turn.... Flight of Human Capital

•Brain Drain

•Brain Gain

Brain Circulation

Grand Challenges

Industrial R&D

 Balancing Expansion, Inclusion, Excellence

Inclusive Innovation

What is Innovation?

'Innovation is the successful exploitation of a new idea' Through Innovation we achieve More from Less for More

Industrial Enterprises aim at

Getting More(Performance)

From Less (Cost)

For More (Profit, value to the shareholder)

Inclusive Innovation

Getting More from Less for More and More People

More and More People

4 billion people with income less than \$2 per day!

Need not 'low cost' but 'ultra low cost solutions'.

Need not 'affordability' but 'extreme affordability'

High



High



High

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From Less

For More

Inclusive Innovation

Getting More from Less for More.....

For More...

People Planet Prosperity

Inclusive Innovation

- Health For ALL!
- Ultra Low Cost
 Diagnostics
 Therapeutics
 Vaccines
 Surgeries

Current Drug Development Getting Less from More for Less

10years ago	Today
\$250 m	\$1.5 b
10yrs	15yrs
~40	~30
	10years ago\$250 m10yrs



Psoriasis Treatment

Cost of Treatment: \$2000! \$100?

Time for Development: 10 rs 5 yrs?

Cost of Development: Few hux red million dollars <\$10 mn?</p>







Modern Medicine



Modern Science



Reverse Pharmacology Process



Men



Mice



Men

Indian Psoriasis Breakthrough



Before treatment

After treatment

Getting More from Less for More

More From Less For More

Cataract Eye Surgery				
US Costs	\$ 3,000			
Aravind Eye Care	\$30 - \$300			

Surgeries: ~ 300,000 per year

More(higher quality) from Less (cost)

Event	Royal College of Ophthalmologists, UK	Aravind
Capsule rupture	4.4%	2.0%
Iris trauma	0.7%	0.3%
Iris prolapse	0.07%	0.01%
Anterior chamber collapse	0.5%	0.3%
Loss of nuclear fragment	0.3%	0.2%
Retained lens material	1.1%	0.87%
Loss of IOL into vitreous	0.16%	0.01%





Heroes of Medicine The \$28 Foot

THE GLOBAL SCOURGE OF LAND MINES LEFT THOUSANDS LIMBLESS, AND THEN TWO GIFTED INDIANS DEVELOPED

The \$28 Foot

BY TIM MCGIRK





Doing More from Less for More: The Emergence of Gandhian Engineering C.K. Prahalad R.A. Mashelkar

In Press Harvard Business Review 😵

India and the future

 By 2050- 61% of Indian population in working group (15-59 yrs)= 900 mn

18 % of world's working age population

 1 in 6 persons of global workforce will be an Indian



"India could have the second largest economy in the world (larger than the US) of \$36 trillion, and a per capita income of about \$22,000 by 2039"

Challenge for Indian Innovators

Look at the stars with feet on the ground