ASSESSMENT OF SCIENCE AND SCIENTIFIC INSITUTIONS : A PERSPECTIVE

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SCIENCE AND TECHNOLOGY IN INDIA : A CHRONOLOGY

•Council of Scientific and Industrial Research	1945
•National Chemical Laboratory	1950
•The Atomic Energy Act	1948
•Bhabha Atomic Research Center	1957
•First IIT at Kharagpur	1954
•All India Institute of Medical Sciences	1957
•First Agricultural Research University at Pantnagar	1960
•Indian Space Research Organization	1969
•Launch of First Sounding Rocket	1963
•Department of Science and Technology	1971
•First Atomic Device Detonation (Pokharan)	1974
•First Indian Satellite, Aryabhata	1975
•Department of Ocean Development	1981
•National TV Network	1982

SCIENCE AND TECHNOLOGY IN INDIA

The three phases

- The infrastructure build up phase (1947-60)
- The assessment and reorientation phase (1960-80)
- The accountability and performance phase (1980-90)
- The economic liberalization and market orientation phase (1990 -)
- *Science and Technology policy statements*
- Science policy resolution 1958
- Technology policy statement 1983
- Science and technology policy 2003
  - Reforms in academic scientific systems
  - Measures to increase public private partnership in R&D
  - Importance of Intellectual Property as an instrument of wealth creation

THE INDIAN NATIONAL INNOVATION SYSTEM
INSTITUTIONS OF GOVERNMENT

- The Atomic Energy Research Establishments
- The Council of Scientific and Industrial Research
- The Indian Council of Medical Research
- The Indian Agriculture Research Institutions
- The Indian Space Research Organization
- The Defense Research and Development Organizations
- The Indian Metrological Department
- Research Institutes of the Departments of Science and Technology, Biotechnology and Ocean Development
- Ministry of Non Conventional Energy Resources
- Ministry of Communication and Information Technology
- Ministry of Environment and Forests

THE INDIAN NATIONAL INNOVATION SYSTEM : HIGHER EDUCATION AND RESEARCH

- **IIT = 15, IIM =7, NIT = 10, IISER = 5 Central Universities = 23, State Universities = 217, Private (deemed) Universities = 130, Colleges = 17,625, Institute of Medical Sciences = 6, Medical Colleges = 783, Teacher Training Colleges = 900**
- **Total enrolment = 17 million**
- **Number of engineers graduating per year > 300, 000**
- **Number of Ph.D's granted in science and engineering = 6000 ; aspiring to increase it to 15000 by 2015**
- **Expenditure on education : 4.5% of GDP**

R&D EXPENDITURE OF MAJOR SCIENTIFIC DEPARTMENTS

Ministry / Department	% share
•Atomic energy	41.4
•Space	15.2
•Agriculture	9.8
•Scientific and industrial research	7.3
•Environment and forests	7.0
•Science and technology	6.6
•IT	3.9
•Renewable energy	2.6
•Biotechnology	1.8
•Medical research	1.3
•Earth and ocean systems research	3.0
Total expenditure	US $ 3.3. billion

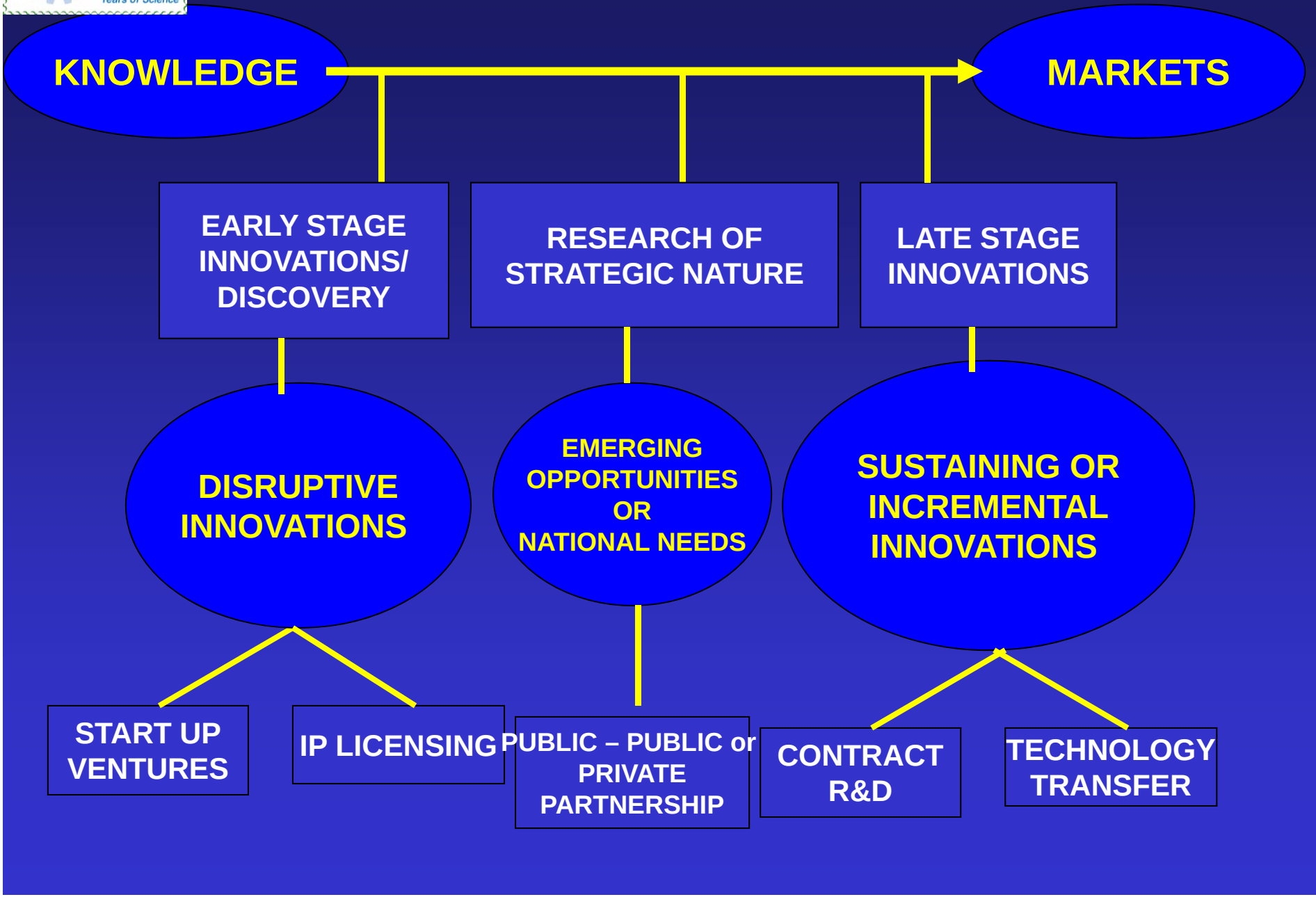
EXPENDITURE ON R&D BY FIELD OF SCIENCE (2000)

	% Share expenditure	
	Public	Private
Natural Science	87	13
Engineering and technology	88	12
Medical science	35	65
Agriculture	77	23
Total	72	28

SCIENCE → *SOLUTIONS* → *MARKETS*

- **Desirable**
- **Feasible**
- **Viable**

LINKING KNOWLEDGE TO MARKETS



NATURE OF RESEARCH

- PI driven funda-mental research
- Problems tend to be narrowly defined
- Education is the primary goal
- Teaching and mentoring is a core activity of faculty

- Team driven multi-disciplinary research
- Problems need to be large and difficult
- Larger degree of application focus
- Long term needs of industry and society
- Education is an associate goal

- Team driven multi-disciplinary research
- Objectives business driven
- Focus – short and medium term

RESEARCH ENTERPRISE : COMPLEXITIES

- **Individual or solo research**
- **Collaborative research**
- **Mission driven research**
- **Research leading to IP**
- **Research leading to products and prototypes**
- **Research aimed at societal needs**
- **Teaching , mentoring and communication**

RESEARCH ASSESSMENT : CHALLENGES

- **Quantity and quality**
- **Consistency in performance, not occasional peaks**
- **Credit to coauthors**
- **Early stage and late stage careers**
- **Individual and institutional assessment ; skewed distribution of performers**

SCIENCE OF SCIENCE MEASUREMENTS

- **Necessary evil**
- **Tangible and intangible rewards**
- **Many weaknesses; favor established scientists, does not capture all aspects of scientific activities that support and transmit scientific ideas**

HAZARDS OF ASSESSMENT

- **Poor metrics or overemphasis and linking them to personal rewards leads to perverse and devious human behaviour**
- **Misuse of metrics (eg average impact factor)**
- **Good metrics that are fair and acceptable to the scientific community is necessary, but difficult to develop**
- **Poor metrics impact funding decisions and sideline good scientists**
- **Good metrics must be grounded in theory, data driven and owned by the community of scientists**
- **Strong incentives to use them uniformly across all decision making**
- **Scientists generally are reticent to see themselves or their institutions labeled, customized or ranked**

OPEN AND CONSISTENT DATA INFRASTRUCTURE

- **Lattes data base in Brazil**
- **Unique research identification numbers or Open Researcher and Contributor Number**

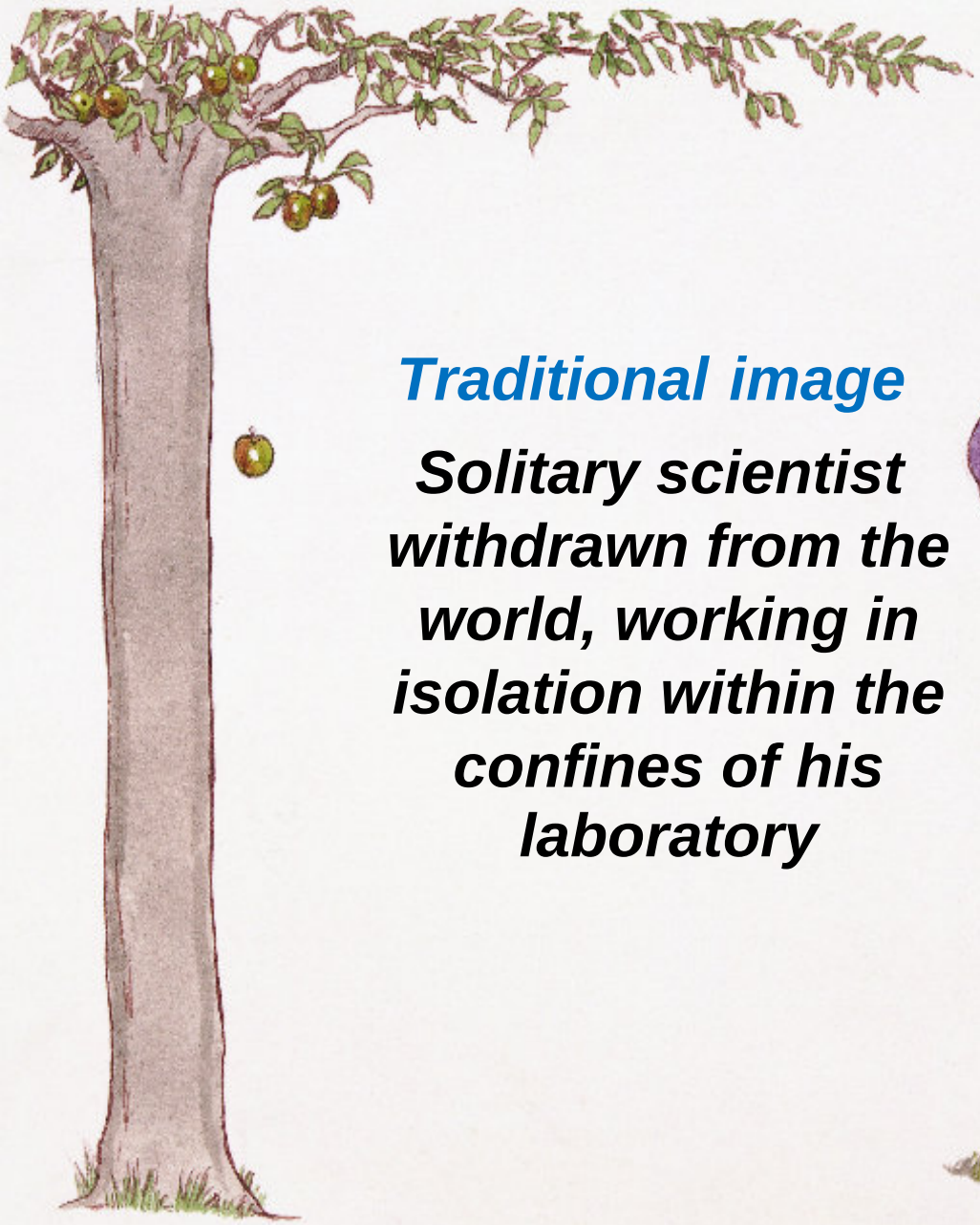
DIVERSITY OF MEDIUM OF SCIENTIFIC DISCLOSURE

- **For profit and not for profit publications**
- **Open source and open access archives**
- **Scientific reports to funding agencies**
- **Symposium proceedings and preprints**
- **Patent literature**

SCIENTISTS : SOLO OR CONCERTED?

AH Cottrell The Listener 1960 Sept 13 411

- **The scientist, however, remote he may seem is bound closely to the scientific life around him. He cannot work in a vacuum. He, both, takes and gives in the scientific currency of his time.**
- **Keeping in touch is the thing and that means meeting as many people working in the field**
- **This is because science is at heart a progressive evolutionary subject and a collective endevour**



Traditional image

Solitary scientist withdrawn from the world, working in isolation within the confines of his laboratory

WHERE ARTS IS AHEAD…

Organizing scientific research on the scale of big operatic and theatrical production is still something new in science

ATTRIBUTES OF A SCIENTIFIC TEAM

Unpredictable

- **Problem Solvers**
- **Integrator**

Predictable

- **Implementors**
- **Problem Finders**

Simple **Complex**

Roles range from creative generators of new ideas to coordinators who keep everyone working together

MEASUREMENT OF SCIENCE : SOME CONCLUDING THOUGHTS

- **Fifty years after the first quantitative attempts at citation indexing, still there are no acceptable and flexible metrics**
- **Citations and h- indices are good measures to identify exceptional performers ; they are not useful in discriminating between scientists of average attainment**
- **Far sighted action can ensure that metrics goes beyond identifying “star” researchers, nation or ideas, to capturing the essence of what it means to be a good scientist**


1950 - 2010
Celebrating Sixty
Years of Science
THANK YOU