



Science & Technology in India: Before and After Independence

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Abstract

Before Independence we had four Nobel Laureates for their work in India. After Independence we have five Nobel Laureates of Indian Origin but no Nobel Laureate who had been awarded for his work in Indian Universities or Research Lab. This enigma can be solved if we look at developments in PRE and POST Independent India. In Colonial India, Britishers had established three Presidency Universities, eight Research Establishments from utilitarian point of view, seven Research Institutions and one University had been established due to persistence of Visionary Patriots J. N. Tata and their like. All these Establishments and Institutions were World Class with no compromise on Professional/Academic Excellence. After Independence we have 400 National R&D lab, 231 Universities and 1300 in-house R&D. Still our quality of Research has fallen over the last six decades because of serious compromises made on Professional/Academic Accountability. In 1981-94 period our share of Global Research Papers was 2.4%, our share of Global Citation was 0.7%, Relative Citation Impact was 0.27 and percentage of GDP spent on R&D was 0.7%. We also occupied NINTH position in 10 most Active Countries in Scientific Publication. By the year 2006 the same has stagnated below 3%, percentage of GDP spent on R&D remains at 0.7% and we have lost our position of eminence among the ten most active countries to China. China today is in FIFTH position and is vying for the SECOND position among the 10 most Active Countries in Scientific Publication. Among the best 500 Universities today we have only 3 Universities whereas China has 8 Universities. We have the capacity to produce 15000 M.Techs but we are producing only 5000 M.Techs. A large number of Engineering Graduates are going into Software Industries and Information Technology Industries. So we are having a serious dearth of Ph.D. students leading to acute shortage of teachers in Engineering College and Science Colleges. Our Private Sector Capital Base is \$300 billion out of which \$200 billion is concentrated in 36 families still only 0.1% of total turnover is being spent into In-house R & D which is 15% of the total R & D funding in India. State share in R & D is only 0.1% of total outlay. If all these

developments are taken into account then we can account the enigma as to why we lack a Nobel Laureate working in Indian Research Environment. Under the circumstances a concerted effort needs to be made by State as well as the Center for revamping the University Systems, incentives have to be given to the Private Sector for increased In-house R & D and Research Institutes have to realize that Real life National Industries are the source of Research Papers. But most of all a system of Professional/Academic Accountability has to be made operative and respect for Professional/Academic Excellence and Integrity has to be restored which was present in British Times but is totally lacking today. This also raises the question that China has succeeded where India has failed though both started with the same initial conditions. British had a Bourgeoisie Mindset. They obeyed the laws and made their subordinate in their Colonies to obey the same. There was no exception. Even Lord Clive was tried by law and punished for his financial irregularities. But independent India is a Bourgeoisie Democracy in name. In essence it still remains Semi-Feudal and Semi-Colony of SuperPowers. Casteism, Nepotism and Sycophancy rules the roost. Such is not the case with China. It has a set of Rules and Laws and it makes sure that all live and play by the same Rules and Laws. Rule of Law is not an exception in China nor was it in British India. But in Independent India it is the Rule of Connections. If you are properly connected you can break the law with impunity.

Indian science & technology in British India[1]

British came as Mercantile Traders humbly seeking trading rights in the Royal Courts of Jehangir in 1650's. This was the era of Mercantile Capitalism. In 1757 Governor General of East India Company, Lord Robert Clive aggressively pursued his marketing rights which resulted in Plassey's Battle in which Nawab of Bengal met his ignominious defeat due to the treachery of Mir Zafer. East India Company was hell bent to seek its Trading Rights by all means including force. In next hundred years they turned whole South Asia extending from Afganistan to Burma into their Captive Market. East India Company tried to maim our Indian



Artisanship as much as they could and compelled us to trade with them on unequal terms. They turned India into their raw material and minerals appendage. Mechanized Production had started in Britain. This was the era of Industrial Capital. Their excess Industrial Produces had to be dumped at huge profits and there could be no better place than their Colonies. Their indiscriminate exploitation of our agricultural resources, mineral resources and maiming of our artisans led to Nation Wide Revolt culminating into First War of Independence. Lack of a Party and an Ideology led to the failure of this popular uprising. East India Company was replaced British Crown and British Empress officially became the ruler of British India. This was the time when Laissez faire Capitalism was being replaced by Cartels, Syndicates and Monopolies. This was the period when Industrial Capitalism was being replaced by Finance Capitalism. This was the period when Export of Commodities had to be replaced by Export of Capital. Direct Investment of British capital in South Asian Continent demanded trained personnels plus a modern Infrastructure. In Lord Macaulay's words,

“ We must presently do our best to form a class of persons who are Indians in blood and colour but English in tastes, in opinions, in morals and in taste.”

With this objective and with the objective of laying down the much needed infrastructure for their ongoing investments, our Colonizers from their utilitarian point of view had created World Class Transportation, Tele-Communication and R&D Infrastructure. Table(1) tabulates the R&D infrastructures and the objective with which they were built. Each of this was there for a certain objective – not just Research for fundamental enquiry but Research which will have commercial spinoffs. This objective was relentlessly and rigorously pursued. There was never any relaxation in Accountability, Excellence and Integrity. Thus a Research Environment was created where Nobel Laureates like C.V. Raman and Ronald Ross were groomed and allowed to bloom into their full glory. It was this environment which also prepared our Visionary Engineer Visheshwarya. Table (2) gives the list of Nobel Laureates of Indian Origin before and after Independence. Now let us see what happened after 15th August 1947.

Indian science and technology in independent india.

On the midnight of 14th-15th August 1947 our Nation and our Representatives made a tryst with Destiny.

‘Long years ago we made a tryst with destiny, and now the time comes when we shall redeem our pledge, not wholly or in full measure, but very substantially. At the stroke of the midnight hour, when the world sleeps, India will awake to life and freedom. A moment comes, which comes but rarely in history, when we step out

from the old to the new, when an age ends, and when the soul of a nation, long suppressed, finds utterance. It is fitting that at this solemn moment, we take the pledge of dedication to the service of India and her people and to the still larger cause of humanity.’

At this moment of time on 18th March 2008 almost 60 years after that historic utterance of our Visionary Leader Pandit Jawaharlal Nehru, I would like to ask our present set of leaders if indeed that pledge of EQUALITY of OPPORTUNITY and STATUS, enshrined in the preamble of our Indian Constitution, has indeed been redeemed. This question will be answered at the conclusion of this article.

Nehruvian Model of Development based on Socialism, Centralized Planned Economy and National Ownership of Producer Industries was put forth. Education and Health Care was to remain under Public Control.

Today in 2008 we have increased our Education and R&D Infrastructure manifolds as is evident from Table(3).

1947	2008
15 National R&D facilities.	400 National R&D Laboratories
4 Universities	231 Universities
?	1300 in-house R&D facilities
50 per 100,000 college enrolment	613 per 100,000 college enrolment (corresponding figure for USA is 5,399 per 100,00)

We have Department of Space which has put us in Space League amongst the community of Nations. Today we have commercial launching capabilities. We have remote sensing and communication Satellites and the most powerful launch vehicles which can launch Intermediate Range Ballistic Missiles(ICBM).

Under the able guidance of InterUniversity Center for Astronomy and AstroPhysics, Giant Meter Wave Telescope has been established which is carrying out pioneering Research in the field of QUASERS and Pulsars. Under the able guidance of Center of Advanced Computing and with the application of Karmakar Algorithm and active participation of Narendra Karmakar, we have been able to develop Tera FLOPS Super Computer which is equal to the best super computer in the World. Our Public Enterprises have been able to manufacture all the needed Power Plant Equipments thereby making us free of Foreign Dependence. Same is the story of Department of Atomic Energy. Today we have Uranium enrichment facilities, heavy water manufacture facilities and we have several Atomic Power Plants working successfully in different parts of our country.



We have been able to develop indigenously 40,000 line Digital Switching Technology which has enabled the Modernization of Telecommunication Infrastructure. Our Drug and Pharmaceutical Industries have also grown from Rs 4 crores in 1947 to Rs 7000 crores with

Rs100 crores invested in Drug related R&D. Our Software exports are growing at 50% per year rate.

Table(1) Growth of Scientific Institutions before Independence[1]

Year of establishment	Name of Institution	Purpose of establishment	Person behind it
1767	Survey of India	Preparing Maps	
1851	Geological Survey of India	Exploring minerals and oil-wells	
1857	Indian Meteorological Department	Weather Forecasting	
1857	3 Presidency Universities: Bombay, Calcutta and Madras	For imparting World Class Education and carrying out Research	
1876	Indian Association for Cultivation of Science, Calcutta	For carrying out Research. Raman Effect was discovered here.	Mahendralal Sircar
1890	Botanical Survey of India	For exploring the Flora Reserve of India	
1896	Halfpenny Institute of Mumbai	For developing Vaccines	
1903	Agricultural Research Institute, Pusa	For Agricultural research	
1906	Forest Research Institute, Dehradun	For Forest Research	
1909	Indian Institute of Science, Bangalore	For Scientific Research in all fields of Physical Sciences.	J. N. Tata.
1911	Indian Research Fund Association	For Research in Life Sciences.	
1916	Benars Hindu University, Benaras	For Research and Education in both Physical and Life Sciences	Madan Mohan Malviya.
1930	National Academy of Sciences, India.	For Research in Astrophysics and allied Physical Sciences	Meghanand Saha- authored a treatise on Heat
1931	Indian Statistical Research Institute, Calcutta.	For Research in Mathematics	P.C. Mahalanobis
1934	Indian Academy of Sciences, Bangalore	For Research in Physics	C.V. Raman
1935	Indian National Science Academy, Delhi	Umbrella Organization for coordinating Research in Life Sciences as well in Physical Sciences.	
1942	Council of Scientific and Industrial Research	For setting up and coordinating Research in various parts of the country in every conceivable area of Scientific and Technical Research.	A. Ramaswamy Mudaliar, B. S.S.Bhatnagar



Table(2)Indian Laureates Before and After Independence[Wikipedia].

Indian Nobel Laureates before Independence			Nobel Laureates after Independence		
Year of Award	Name of the Awardee & Nationality	Field of Award & Place of Research	Year of Award	Name of the Awardee	Field of Award & Place of Research
1902	Dr. Ronald Ross, Englishman.	(1)MEDICINE (2)Presidency General Hospital , Kolkota,	1968	Dr. Har Govind Khurana, Indian later became US citizen.	(1) MEDICINE (2) USA
1907	Ruydurd Kipling, Englishman.	(1)LITERATURE (2)Shimla	1979	Mother Teresa, Bulgaria	(1) PEACE (2) Kolkota
1913	Rabindra Nath Thakur, Indian.	(1) LITERATURE (2)SantiNiketan University, Bengal	1983	Dr. S. ChandraShekher, Indian later became US citizen	(1) PHYSICS (2) Chicago University,US A.
1930	Dr. C.V. Raman, Indian	(1)PHYSICS (2) Indian Association of Cultivation of Science, Kolkota.	1998	Dr. Amratya Kumar Sen, Indian.	(1) ECONOMICS (2) Cambridge University,England
			2001	Vidyadhar Surajprasad Naipaul, Englishman of Indo-Trinidadian Origin.	(1) LITERATURE (2) England.
			2007	Rajendra Prasad Pachauri, Indian.	(1) PEACE (2) Inter-Governmental Panel, USA.

Tata Research Development and Design Center (TRDDC) established in 1981 has emerged as a viable profit making R&D facility which does sponsored Research for Private and Public Industries, Indian and foreign both.

Small-Scale Industry is a vibrant and dynamic sector with 2.3 million units, producing 7000 items and providing jobs to 14 million workers which is 10% of total work force. SSI provide 40% of Merchandise Exports.

This clearly shows that we have a large and modern infrastructure which has made its marks where Government has shown political will e.g. in the field of Space Technology, Computer Technology, Atomic Power Plant, Telecommunication and Software Technology.

Our Private Industrial Assets is \$ 300 billion worth. We have 36 business houses who figure in Forbes Billionaires List still none of the top 100 brands belong to Indian Business House. Furthermore we have missed the Integrated Circuit Technology revolution. We even today have no Silicon IC Fabrication facility barring Semiconductors India Limited Chandigarh which is more of a Govt. Show piece.

We were an Agrarian Economy and the objective of Nehruvian Model was to turn India into a Self-Reliant Industrial Economy which we still are not. Industries constitute only 19.3% of GDP, Agriculture constitutes 19.8% and Service Sector constitutes 60.8%.

Why do we remain a developing economy?



The malady of our economy.

During the growth of Civilization we have moved through three stages:

(i) Labour Intensive Method of Production which was primarily Agricultural Economy;

(ii) Capital Intensive Method of Production which was Industrial Economy;

(iii) Knowledge Intensive Method of Production which is today's Post Industrial Era.

In the present era, generation of Scientific Knowledge is intimately linked to GDP and per capita GDP as is evident from Figure 1.

FIGURE 1. Comparing economic and scientific wealth.[3]

From the following article:

[The scientific impact of nations](#)

David A. King

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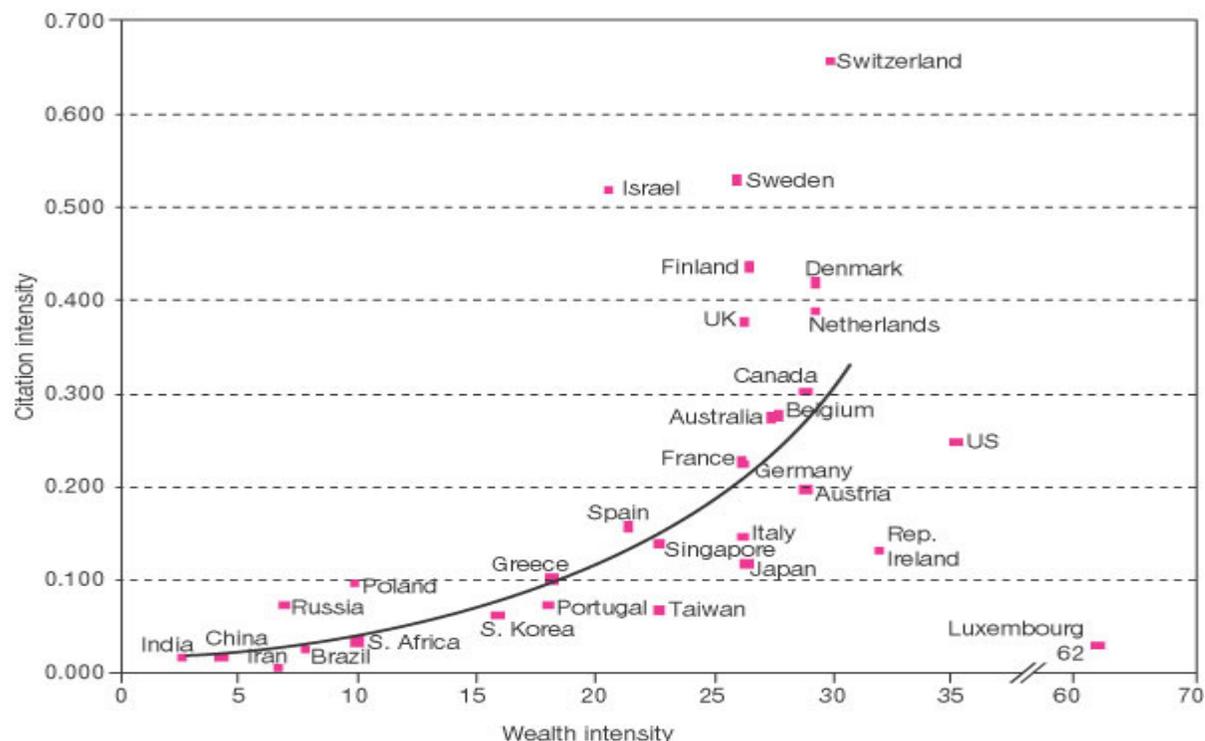


FIGURE 1. National science citation intensity, measured as the ratio of the citations to all papers to the national GDP, shown as a function of the national wealth intensity, or GDP per person, for the 31 nations in the comparator group. GDP and wealth intensity are given in thousands of US dollars at 1995 purchasing-power parity. Sources: Thomson ISI, OECD and the World Bank.

As seen from the Graph ,National Science Citation Intensity is directly related to Wealth Intensity where the two terms are defined as follows:

Citation Intensity=(Total Citations/GDP)

Wealth Intensity=(Total GDP/Total Population)

The Scientific Publications of top 31 countries and their Citations have been studied in detail from 1981 to 2005[2,3,4].

TABLE 4. World's 10 Top Countries in Scientific Publications in descending order.[4]

Countries	1991 (%)	Countries.	1998 (%)	Countries	2005 (%)
USA	35.6	USA	32.3	USA	30.5
GBR	8.6	JPN	9.2	JPN	8.3
JPN	7.6	GBR	9.2	GBR	8.2
DEU	7.3	DEU	8.7	DEU	8.1
SOV	5.6	FRA	6.3	CHN	7.5
FRA	5.5	CAN	4.2	FRA	5.7
CAN	4.7	ITA	4.0	CAN	4.5
ITA	3.1	RUS	3.5	ITA	4.4
IND	2.4	ESP	2.8	ESP	3.3
AUS	2.2	AUS	2.7	AUS	2.9



As can be seen from the Table 4. in 1991 India was at ninth position with 2.4% of share in Global Publications whereas by 1998 onward it is no more in top ten whereas China which was far behind in total publication as well as in total citation in 1981 has surged forward to 5th Position in top 10 in terms of total Publications and it is likely to achieve 2nd position in next couple of years.

Table 5. does a comparative demographic comparison of India , China and USA. In the year 2006 [5]

Resource	India	China	USA
Land Mass (million. sq. km)	3.29	9.6	9.63
Population (billion)	1.1	1.31	0.298
Median Age(Yrs)	24.9	32.7	36.5
Birth Rate/1000	22	13.3	14.1
GDP(1) Trillion Dollars	3.61	8.86	12.36
GDP(2) Trillion Dollars	0.72	2.23	12.49

1. Purchasing Power Parity, 2. Official Exchange Rate.

Table 6. gives the scenario of Scientific Publication, total Citations gathered and %GDP invested in R&D in the period 1981-1994. [2]

TABLE.6. Comparison of total number of papers, total citations and % GDP for India and China. (1981-1994)

	India	China
% of Global Publications	2.4	0.9
% of Global Citations	0.7	0.3
Relative Citation Impact =(% citation/%publication)	0.27	0.27
% GDP invested in R&D	0.7	0.5

Both India and China were agrarian economies coming out of colonial bondage and facing equal intensity of poverty, illiteracy and unemployment. China was ostracized by USA and Capitalist Worlds and later it was boycotted by Soviet Union also. Then how come China was able to bring itself out of morasses of poverty and illiteracy and we seem to be sinking deeper and deeper in the same.

Just as in British India there was accountability and professionalism , China had the same kind of work ethos though because of altogether different reasons. British had to extract the maximum from us for all their investments in their colonies whereas for China it was the question of very survival surrounded by capitalist sanctions and trade embargoes. This unfortunately has been lacking in India.

The Ruling Class in India is totally blinded by greed and avarice so much so that it has lost the very National Perspective. It is this loss of National Perspective which is compounding the problems and leading to secessionist and revolutionary movements

through out the country. Under the circumstances all well meaning plans of poverty alleviation and employment generation fall on their face without reaching any of its objectives.

IV. REMEDY AND CURE OF INDIAN POLITICAL ECONOMY.

Following are the recommendations in the bleak and desperate situation we have fallen into as a Nation:

(1) The rot which has set in every level of education right from Primary Level through Secondary Level to Graduate and Post Graduate level have to be urgently addressed;

(2) British atleast had a system of training first rate Babu Engineers, Babu Doctors and Babu Clerks;

(3) In Independent India we are still producing Babus only through our educational systems but not first rate. Our Babus are second rate and third rate professionals not ready to face the challenge of building a Modern India;

(4) State participation in building R&D facilities have been negligible in plans after plans. In 8th Five Year Plan total outlay of States and Union Territories was Rs 182,000 crores but only Rs 200 crores was allocated to S&T Infrastructure. This comes out to be 0.1% of the total outlay. States donot see that S&T is the only weapon by which they can fight poverty, unemployment and illiteracy;

(5) Private Business Houses have equal capital base as compared to Public Sector Enterprises i.e, of \$300 billion still Private Business contribution to R&D efforts is only 15% of the total. It must be 50:50;

(6) It must be realized that Research cannot be done for Research sake it has to be linked with Real Life Industries.

But these recommendations become meaning less until the rule of law is established in this country where the rich and powerful are flouting the law with impunity.

Acknowledgment

I would like to express my gratitude to BBrains Development Society for their pioneering effort to start an intellectual ferment and thereby start a new era of research and enquiry.

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Post Sript: On 15th January 2008 , Drug Controller General of India cancelled the production license of three Public Sector Undertakings for Vaccine-Manufacturing. These Public Enterprises did not comply with Good Manufacturing Practices Norms as set under the Indian Drugs and Cosmetics Act of 1945. These Unit are:

- (1) Central Research Institute, Kasauli, Himachal Pradesh;
- (2) Pasteur Institute of India, Coonor, Tamil Nadu;
- (3) BCG Vaccine Laboratory , Chennai, Tamil Nadu.

Since 1978, under Expanded Programme of Immunisation, these companies produced the bulk of vaccines for six vaccine- preventable diseases namely: diphtheria, pertussis, tetanus, poliomyelitis, typhoid and childhood tuberculosis. In 1985 this programme was upgraded to Universal Immunisation Programme(UIP). Under UIP typhoid was replaced by measles. Thus under UIP we have Bacillus Calmette-Guerin(BCG) vaccine, the triple diphtheria-pertussis-tetanus (DPT) vaccine, the oral polio vaccine(OPV) and the measles vaccine.

This is a serious blow to our self-reliance and indigenisation objective and it reflects upon the state of higher education. If there were academically sound people they would never compromise on standards and norms. But they did and the result was catastrophic. Today even the vaccines in their stock are not being permitted to be used for UIP.

This story of compromise today is the common theme through out all technical and academic institutes leading to sub standard engineers, doctors and academicians and hence to production of sub-standard products.

TABLE 5. Comparative study of Technical Manpower in India and US.

	India 2008	USA 2008
Engaged in R& D	116,000	1.3 million
Per Capita Manpower	110 per milion	4500 per million
Science Graduates per yr	9 million	
PG Science per yr	2 million	
Ph D's per yr	100,000	
Fresh Science Enrolment per yr	2 million	
Fresh Engineering enrolment per yr	700,000	
Private Sector contribution to R&D	14%	63%
IT-BPO Industries	8-10% of our 495,000 engineering graduates qualify. Several Thousands Graduates hired from outside.	