Foreword : January 2010

Revisiting Homi Bhabha's *Growing Science* Model

1.Inaugurating the 97th Indian Science Congress jointly organized by Indian Space Research Organization and University of Kerala in the capital city Thiruvananthapuram of "God's Own Country" (?) on January 3, 2009, Prime Minister summarized the latest policies and perspectives of the Union Government and also highlighting the major initiatives taken by it. He enumerated climate change, clean energy, biodiversity, natural resource management, safe utilization of genetic modification technology, affordable health care, and so on, as the major S&T challenges facing the nation. Emphasizing the need for India to emerge as a "knowledge power in the 21st century", he asked the scientific community to work for greater "autonomy from red tape and local politics" and urged our scientific institutions to "introspect and propose mechanisms for greater autonomy including autonomy from the government, which could help to improve standards" and work to "convert the 'brain drain' of the past into a 'brain gain' for the future". Declaring 2010-20 as the "Decade of Innovations", he sought new solutions "in healthcare, energy, urban infrastructure, water, and transportation, to name only a few". He highlighted the need "to think creatively on how to increase private investment in R&D" needing "some innovative policy readjustments to build vibrant Public-Private Partnerships in the S&T sector", all these in turn "to give a new boost to science in India". He concluded by emphasizing that ***"we need to concentrate on strengthening the linkages between academia, research and industry…(and) unless we close those gaps, our R&D sector may report high performance in terms of published papers but our challenges of the 21st century will remain unsolved"(emphasis added-ADD).***

2. Leaving aside for the present the priorities enlisted by the present government for whatever they are worth, there is hardly any new major policy issue in the PM's speech and which has not been repeated earlier through the years ad nausea by many political leaders in authority, including late C Subramaniam as early as in 1972 through the first document of the newly constituted National Committee on S&T, the deliberations of which in turn gave rise to the establishment of the new Department of S&T, itself vested with the above task of bringing in greater linkages between R&D and production. It is well known that 1991 was the beginning of a New Economic Policy Regime enlisting all aspects of national development including future of S&T. There were many suggestions by the distinguished assemblage of our academia and R&D centers and in a note independently submitted by this author for the pre-budget meeting held by the then Finance Minister (who became Prime Minister in 2004) on January, 15, 1993, it was emphasized that (a) a new strategy must be found to develop this crucial sector matching with the New Economic Policy of the government.(b) the open door policy of modernization will ultimately succeed only, and only, if the imported technologies are assimilated, innovated and made economically more competitive in the global market (c) whereas, like in advanced countries, the public-funded S&T infrastructure must play a state-of-art, pioneering and consultative role, industries will have to play the primary role of assimilation, innovation and cost reduction through their own use-specific research institutions, leave alone creation of proprietary technologies and products (d) *hence the*

need to formulate policies which will promote both public funded and industry-based research units in the country as part of the new initiatives of the government to modernization. The same Note had listed a few feasible policy proposals as well.

Unfortunately, however, the developmental policies were being re-oriented on a different strategy altogether arising from the political decision of the government to 'open up' the economy, become a member of the World Trade Organization, accept wide ranging changes in the TRIPS dictated IPR Regime and so on in a *totally ill-equipped mode*, *certainly at least as far as S&T dictated techno-industrial development was concerned*.

As detailed in a research review paper "Indian Patent Law in the post-TRIPS Decade: An S&T Appraisal" in Journal of Intellectual Property Rights Vol. 13, September 2008, "A first level S&T appraisal of the post-TRIPS decade seems to indicate that major policy initiatives are needed to retain the past gains and to put the nation-building process truly on the forward path, failing which the existing 'knowledge barriers' may become even wider beyond our scientific-technological capabilities". In turn, the summary concluded "Even a first level S&T appraisal of the decade long new regime seems to be in agreement with the above. Obviously Indian S&T needs a serious re-look, more so after a decade-long post TRIPS compliance, with a new science-technology-industry policy and a patent-cum-competition law to closely support and augment it. In an excellent monograph "Between MITI and the Market" (Daniel I. Okimoto, "Between MITI and the Market", Stanford University Press), Daniel I. Okimoto has described in great detail how MITI had played a historic role in transforming the war-torn Japan into a modern techno-industrial-economic power. To quote him, "Of the industrial countries that have relied heavily on industrial policy, it is hard to find one that has not had to pay the high price of economic inefficiency or trade tensions. Japan is cited as an unambiguous success story…the effectiveness of industrial policy is revealed in the successful emergence of one industry after another as world-class competitors: steel, automobile, semi-conductors", and so on. Lest we forget, Japan had a *matching* patent law and competition law as well to match the policy requisites, leave alone its unique development banking structures and other promotional features. The pioneering study by Sanjaya Lall (Sanjaya Lall, "Technological Capabilities and Industrialization", World Development, Vol. 20, No. 2 (1992)) on Korea and other East Asian Economies also point out to only similar conclusions. **The Growing Science Model of Homi Bhabha formulated in mid-sixties for India (implemented only in DAE and later in ISRO) has much in common with the former ones. Perhaps Indian policies could be revisited on those models appropriately synergized with contemporary requirements. More on this is beyond the scope of this paper. A Faustian challenge, but then there is no alternative if Indian S&T and industry must be "powered by engines of its own", in the wise description of Homi Bhabha.**

3. The urgency of the task is emphasized based on three crucial indicators of contemporary Indian S&T

(a) According to latest Word Intellectual Property Organization,2009 report, the Indian Patent Office ranks 9th in the number of patents filed and 12th in the number of patents granted, the total number of patents filed in India amounting to 28,940, behind the US (4,56,154), Japan (3,96,291), China (2,45,161), the Republic of Korea (1,72,469), European Patent Office (1,40,763), Germany (60,992), Canada (40,131) and the Russian Federation (39,439). In terms of the number of patents granted, India (at 7,539)

stood behind Japan (1, 64,954), the US (1, 57,283), the Republic of Korea (1, 23,705), China (67,948), European Patent Office (54,699), the Russian Federation (23,028), Canada (18,550), Germany (17,739), France (12,112), Australia (11,236) and Mexico (9,957). The WIPO-compiled data pertains to 2007.

What is significant about India, however, is not just its overall ranking, but also the fact that a majority of patents filed and granted by it was to non-residents (whether companies or individuals). Thus, of the 28,940 patents filed in the country, as many as 23,626 (82 per cent) were by non-residents. This was unlike China, where 1, 53,060 out of the total 2, 45,161 (62 per cent) patents filed originated from resident applicants. Indeed, if one looks at purely resident patent filings, India's ranking falls to 11th (5,314), behind Japan (3,33,498), the US (2,41,347), China (1,53,060), the Republic of Korea (1,28,701), Germany (47,853), the Russian Federation (27,505), the United Kingdom (17,375), France (14,722), Italy (9,255) and North Korea (6,922). In terms of resident patent grants, India (at 1,907) stands at the 13th place, behind Japan (1,40,040), the Republic of Korea (91,645), the US (79,527), China (31,945), the Russian Federation (18,431), Germany (12,977), France (9,748), Italy (5,257), North Korea (4,235), Ukraine (2,505), Spain (2,325) and the UK (2,058).

The substantial increase in patent filings by China and the Republic of Korea is a major development of the last 10 years or so. **In fact, for the first time, a Chinese company – Huawei Technologies – topped the list of applicants to have filed patent applications through the Patent Cooperation Treaty (PCT) in 2008. Huawei filed more PCT applications last year than Japan's Panasonic Corporation (1,729),** the Netherlands' Philips (1,551), Japan's Toyota (1,364), Germany's Robert Bosch (1,273) and Siemens (1,089), Finland's Nokia (1,005), Korea's LG (992), Sweden's Ericsson (984), Japan's Fujitsu (983), Qualcomm of the US (907), Japan's NEC (825) and Sharp (814), Microsoft (805) and Motorola (778) of the US, Sweden's BASF (721), IMB (664) and 3M (663) of the US, Korea's Samsung (639) and Du Pont of the US (517). **Not a single Indian company features in this list. Under the TRIPS compliant regime, patents form the major, if not only S&T indicator of the technological strength of any nation/company and obviously Indian industry both in public and private sectors have "miles to go" to even catch up!**

(b) According to a recent report, France has just lost a 20.4 billion-Euro-bid to supply four 1,400 megawatt nuclear reactors to the emigrate of Abu Dhabi, ***the winner being a South Korean Consortium led by the public sector electricity giant Kepco***. The Kepco-led Korean consortium also includes Hyundai, Samsung and the Japanese Toshiba-Westinghouse combine. The contract, made public on December 27, calls for the "conception, construction and assistance in the running" of four nuclear reactors of 1,400 megawatts each. ***Whereas the giant leaps made by post-war Korea in all civilian sectors including micro electronics continue to attract the awe and wonder of all nations, the leap into the nuclear sector has added a wider dimension into its highly successful Techno-Industrial Policy Regime***.

On the other hand India has over the decades matured itself as a reliable producer of heavy water reactors based nuclear power with its latest Tarapur model at 540 megawatt capacity, thanks to a development strategy based on its "Growing Science" model enunciated by its pioneering nuclear scientist and founder-father, late Homi Bhabha. And yet on a new policy initiative cleared at the highest level of governance to augment its capacity in a *leap-frog mode (?),* steps are on now for large scale import of

higher capacity light-water reactors from many countries including France (for the same Areva reactors!), USA, Canada and so on, with import of larger number of VVVR reactors from Russia being at a more advanced state.

As part of the 97 Indian Science Congress, the organizers had arranged a **Space Summit** in which special lectures were delivered by senior personalities on the work of NASA, European Space Agency and ISRO. Though India has achieved much in terms of its launch vehicles, satellites and also the historic Chandrayaan 1 Mission in partnership with NASA, the true technological gap between ISRO and even China with its proven capability to achieve a manned mission last year, is very wide indeed, leave alone that with the advanced countries. This is even more true between the capabilities of DRDO and others including China in the area of defense technologies including specifically missiles.

In essence, Indian S&T is at a cross road, both in civilian and strategic sectors even in comparison with our Asian neighbors, all of whom having achieved their political independence more or less at the same time; and there are enough reasons to worry whether even our hard-won achievements are in danger if large scale and unrestricted imports are resorted to in respective areas in the name of international competitiveness. *In other words, we have to ponder over the historic development question, what is self-reliance and is it not one topmost agenda as a free nation?*

4. *It is within such a context that one is tempted to attempt a revisit of the "Growing Science" model formulated by Homi Bhabha, the great scientist-engineer for India's Atomic Energy Program and who championed it for the nation itself.* The essence of the Growing Science model (Ref: "Problems of Science Development" International Council of Scientific Unions, Bombay, Jan 1966) and the strategy worked out by Bhabha for nuclear technology under the " growing science " approach had the following major elements:

(a) Evaluation of the technology gap in the field between India and advanced countries in all aspects, including the nature of Intellectual Property Rights related to it, (The nuclear reactor was patented in 1945 itself by Fermi and Szilard in an extensive US patent!)

(b) Importation of appropriate technology wherever feasible without any pre-conditions and thereby utilizing the opportunity to get a quick " assisted take-off",

(c) Systematic development of the appropriate indigenous S&T infrastructure to assimilate the " know-how and know-why " of designs, equipments and systems, and

(d) Providing adequate legal/administrative policy umbrella support for implementing the indigenous development program, including support measures to overcome issues connected with Intellectual Property Rights. Suffice here to say that the Indian Atomic Energy Act 1962 had incorporated all the essential requirements for implementing the DAE program as envisaged.

Thanks to such a farsighted strategy, DAE was able to execute its task with great success, in spite of many a major set-backs not unusual in assimilating such an

'unforgiving technology'. This was despite the most rigorous international non-trade barriers – such as embargoes of large number of items including those belonging to the so-called 'dual use' category from the advanced countries – due to which its programs had to suffer for over a decade through delay in achieving the projected targets delay.

Currently its Nuclear Power Corporation has established a total capacity of 3310 Mwe, and seven more reactors are under construction to take the total capacity to 6730 Mwe, supplying the clean energy to the various grids in the country at rates comparable to those from thermal sources and with plant load factors comparable to those by international nuclear power utilities. The recent commissioning of the 540 MWe capacity Tarapur Units 3&4 has truly added another significant feather to its cap as the test of the consummation of the decade's long accumulated expertise and capabilities in the field – the very dream itself of its founding father coming true in flying colors!

(e) It is based on the above solid foundation, including over 200 reactor years of safe nuclear power plant operation and with its unit at Kakrapra getting even the prestigious WANO Award that DAE has now planned to establish an installed capacity of 20,000 Mwe by the year 2020. This optimism is also based on reasonable prospects for mining of the raw material uranium in new locations in Meghalaya, AP, Jharkhand, MP and Rajasthan.

In short, DAE has gone a long way indeed to fructify the ambition of its founding father Dr. Homi Bhabha to make India a truly self-reliant leader in nuclear technology among the comity of developed nations. It goes to the great credit of DAE that in spite of the powerful Gujarat tremors, its Unit at Kakrapara did not even trip! Even with the mighty Tsunami waves on the Tamil Nadu coast, the Madras Reactors were just shut down automatically and which were restarted within a fortnight itself! Dr Anil Kakodkar in his 28 September 2006 speech before the IAEA had emphasized that: "Our scientists have done excellent work and we are progressing well on this program as per the original vision of Jawaharlal Nehru and Homi Bhabha and we will build on this precious heritage".

5. Undoubtedly, DAE could implement its program so successfully because it had from its beginning the imaginative ***techno-administrative-political policy*** support at the highest governmental level starting with the umbrella support of late Jawaharlal Nehru himself (DAE aptly describes Homi Bhabha and Jawaharlal Nehru as the twin architects of Atomic Energy Program in India). **In essence, DAE was vested with all administrative powers to implement its programs within the political policies decided by the government. Happily enough for the DAE technological self reliance was a well approved strategy of the nation itself and within such a self reliance milieu, DAE could implement its programs within the limits possible under the best milieu in the country.**

(To be continued)

Major S&T Developments

(1) IPR Regime in Indian Agriculture

According to the December 17, 2009 report of Business Line, private seed companies are increasingly queuing up before the Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA) for registering their existing and new developed hybrids/varieties.

The Authority – a statutory body established to protect plant breeders' intellectual property rights and functioning since May 2007 – has so far granted registrations to 117 hybrids/varieties, with the bulk (108) belonging to the Indian Council of Agricultural Research and State Agricultural Universities. The private sector accounts for only the remaining nine, including JK Agri Genetics Ltd (one hybrid each of paddy, sorghum and pearl millet) and the Ahmedabad-based New Nandi Seeds Corporation (six pearl millet hybrids).The registrations issued till date pertain only to 'extant varieties' – those that were already in the market for over one year at the time of application.

But the picture is totally different in respect of "new varieties" (less than a year old), for which the PPVFRA is yet to grant registrations. "If one looks at the nearly 400 new-variety applications, of which 160 or so are at the stage of testing for DUS (Distinctiveness, Uniformity and Stability, which is a qualification for registration), I would assume 60-70 per cent of them are from private companies," the PPVFRA Chairperson, Dr S. Nagarajan, told Business Line. Also, the existing registrations cover only 12 field crops – rice, wheat, maize, pearl millet (bajra), sorghum (jowar), green gram (moong), black gram (urad), lentil (masur), pea (matar), kidney bean (rajmah), pigeon pea (arhar) and chickpea (chana). The PPVFRA has since also added cotton, jute, sugarcane, turmeric and ginger to the list of crops, whose lines can be protected against breeders' rights infringement. Further, the draft DUS test guidelines for potato, brinjal, tomato, okra, cauliflower, cabbage, onion, garlic and rose have been sent for notification in the gazette.

Once notified, the breeders of lines in these crops would also be entitled to a 15-year protection period, during which others are barred from selling their seeds except under appropriate licensing arrangements. Farmers will have the freedom to save, use, sow, re-sow and even sell the seeds of the protected hybrid/varieties, so long as they do not engage in branded sales. "The private sector, including multinationals, has a strong presence in crops such as cotton and vegetables, for which we will start issuing registrations only now. And that will obviously show up in future registrations," Dr Nagarajan noted.

The Indian market for traded seeds (mainly hybrids) is currently estimated at roughly Rs 7,500 crore. This includes Rs 1,800-2,000 crore from cotton (where the top players are Rasi Seeds, Nuziveedu Seeds and Mahyco), Rs 1,500 crore from vegetables (Nunhems, Seminis, Syngenta and Namdhari Seeds), Rs 800 crore from maize (Monsanto and Pioneer Hi-Bred), Rs 600 crore from hybrid rice (Bayer Crop Science and Pioneer), Rs 500-600 crore from bajra (Pioneer and Bayer) and Rs 70-80 crore from sunflower (Syngenta and Ganga Kaveri Seeds). Nunhems, Seminis and Pioneer are the subsidiaries of Bayer Crop Science, Monsanto and DuPont, respectively.

If to this, Monsanto's 26 per cent stake in Mahyco is added, it translates into a substantial multinational presence in the country's hybrid seed business. “The PPVFRA regime is a welcome step to the extent that it acts as a psychological barrier against infringement. Once I register a hybrid or even its parental lines, others would be deterred from exploiting it for commercial purposes,” said Dr Arvind Kapur, CEO (Vegetable Division) of Rasi Seeds. At the same time, it may not be good enough to stop sale of stealth seeds by unorganised players or breeders in farmers' disguise. “No company can go after these people beyond a point. We saw this in the case of illegal Bt cotton seeds,” he said. The PPVFRA maintains a National Gene Bank for storing the seed samples deposited by breeders. “We send a part of the samples to the DUS test centres and the rest is secured under double lock-and-key over the 15-year protection period,” Dr Nagarajan informed.

The implications of such an IPR regime in agriculture with increasing monopoly rights with private seed companies could be serious for the large number of our marginal farmers, who are already struggling with steadily increasing cultivation costs.

(2) Copenhagen Agreement

The Copenhagen Climate Conference has ended without meeting its goal of a legally binding agreement for the second commitment period of the Kyoto Protocol.

Without a treaty committing the rich and industrialized countries to deep emission cuts, the lives and well-being of hundreds of millions of people, especially in the developing world, have been put at risk. This will most adversely affect people in South Asia, large parts of Africa, least developed countries and island nations that could be entirely submerged under rising sea-levels. People all over the world had been hoping that the Conference would chart out a clear course to save humanity and the planet from runaway global warming and climate change. This has not been happened.

The political leaders who gathered in Copenhagen have failed their people by not delivering an effective and equitable climate change agreement. Such an agreement in Copenhagen was made impossible by the positions and tactics of the US and other developed countries. From the first day to the last at Copenhagen, the US and its allies tried their utmost to kill the Kyoto Protocol itself, negate the cornerstone principle of differentiation between the industrialized and developing countries, and pressurize the developing countries to take on the major burden of reducing global emissions.

Their inability to achieve these aims was due to the stiff and united resistance put up by the developing countries, a resistance which was one of the few positives in Copenhagen. Major developing countries such as the BASIC bloc of China, India, Brazil and South Africa, as well as Mexico and Indonesia, voluntarily announced reductions in emissions growth rates in the interests of humanity, going far beyond their obligations under the Kyoto Protocol. However, the US, EU and other developed countries did not budge an inch from the low emission cuts they had declared before Copenhagen. A leaked draft UN Report has revealed that pledges made by large developing countries

will contribute more to emission reductions than the low commitments of the US and other developed nations.

A complete failure in Copenhagen has been averted with the face-saving text of a "Copenhagen Accord" with the promise of a legally binding agreement in 2010. The Accord was crafted in the closing hours of the Conference by the US, the BASIC countries and 22 other developed and developing countries from different continents and groupings. Though the Accord has no legal status and would not bind countries, it at least provides some way of keeping future negotiations going along the current twin tracks. Without this, the failure of the Conference could have meant the collapse of the Climate Treaty and the Kyoto framework.

However, this Accord is extremely weak in terms of the deep and immediate emission cuts by developed countries that are required to tackle climate change. It is deeply ambiguous with several loopholes and the possibility of different interpretations, particularly with regard to emission cuts by developing countries, and fund and technology transfers.

India should therefore ensure that in future negotiations, the red lines committed by the government in Parliament are adhered to. India must also press for deep and immediate emission cuts by the US and other developed countries and work with other developing countries to ensure sustainable development and equitable terms in any final Treaty.

Minister Jairam Ramesh has in a way admitted it. "The accord has certain inbuilt hazards and the developing world, especially India, has to be wary on those accounts. The foremost risk is that the developed world could demand an end to the Kyoto Protocol (based on the principle of equity)," Ramesh, who was here yesterday to review the progress of the Ganga river cleanliness programme, told reporters. He, however, rejected the Opposition's claim that the Copenhagen summit was a failure. "It is a partial victory for the BASIC Group comprising Brazil, China, India and South Africa when it wrested three important benefits from US President Barack Obama at Copenhagen," Ramesh said referring to the two-week negotiations at the Danish capital.

(3) Patents scenario in India

Over 80 per cent of India's patent applications are from foreign firms. Of the 6,000 plus applications that reached patent offices in 2008-09, only 17 per cent were Indian filings, according to the Controller General Shri PH Kurian.

(4) Solar Power Mission to be substantially reduced

"The 20,000 MW plans which envisaged a budget of Rs 270,000 crore has been found to be prohibitively expensive. The mission plan is to provide Rs 17.50 per MW feed-in tariff to solar power generators for 20 years," the member of the Prime Minister's Council on Climate Change said yesterday. "Out of this, Rs 5.50 will be paid by the utilities and the Central Government will pay the rest. The Finance Ministry, however, has made clear that there was no way it could fund this (Rs.270, 000 crore) money." So, the goal is being reduced to 4,000 MW, which would cost the government Rs 90,000 crore over 20 years from the day the mission kicks off, Narain, who heads an NGO Centre for Science

and Environment, said. The Jawaharlal Nehru National Solar Mission is one of the eight announced as India's National Action Plan on Climate Change and will be implemented under the close watch of the Ministry of New and Renewable Energy.

(5) Transgenic rice varieties developed by MSSRF

Indian scientists are developing varieties of transgenic rice tolerant to water stress conditions, Ajay Parida, Executive Director, M.S. Swaminathan Research Foundation (MSSRF), has said.

Field trials of the rice variety that needs little water for cultivation were progressing at Kalpakkam, he told delegates at a plenary session on Biotechnology at the ongoing 97th Indian Science Congress in Trivandrum on Wednesday. Dr. Parida said the MSSRF had developed other transgenic varieties of rice that were salt resistant and drought tolerant. These varieties, impregnated with mangrove genes, were developed under the anticipatory research programme of the Foundation; he said. He said efforts were on to develop a new variety of rice with fortified iron content to address micro nutrient deficiency. The development of the rice with ferritin gene was in the regulatory stage. Other transgenic varieties with heavy metal tolerance and accumulation characters were also in the pipeline. These crop varieties could help in phyto remediation of soil contaminated with heavy metals like arsenic or cadmium.

Dr. Parida said the MSSRF had taken defensive patents on all the varieties under development. Responding to questions, he said field trials had demonstrated a 40 per cent increase in yield for saline-resistant transgenic rice. Biotechnology breeding methods in India were properly regulated, he said.

(6) CSIR sequences human genome

The Council of Scientific and Industrial Research (CSIR), India has added yet another feather to its cap. Scientists at the Council's New Delhi-based Institute of Genomics and Integrative Biology (IIGB) have succeeded in completely sequencing the genome of an individual, enabling India to join a league of select countries — the U.S., the U.K., Canada, China and Korea.

Announcing the "path breaking" achievement, Union Science and Technology Minister Prithviraj Chavan said India had now successfully bridged the technological gap that existed a decade ago. The IIGB scientists were able to achieve the feat within 10 weeks, from September 25 to December 4, duration comparable with recent efforts across the world.

Describing it as a beginning of a new era in Indian medical research, CSIR Director-General Samir K. Brahmachari said a major significance of the Indian effort was that it would help understand several diseases that were of importance to India and other developing countries. The effort would also add to global knowledge on genetic variations and pre-disposition to various diseases, he said.

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