

voices could be heard. The rationale behind the specific recommendations made in the report was detailed carefully and supported by an extensive analysis contained in the appendices to the main report. Finally, the report itself is exceptionally well-written and a pleasure to read, despite its length and the specialized nature of its content.

Returning to the Indian document, it mentions that ‘The stature of Indian science is a shadow of what it used to be... because of decades of misguided interventions. We have lost self-confidence and ambition and the ability to recognise excellence ... we often chose the mediocre at every level’¹. An approach that assumes the inability to recognize excel-

lence might reasonably do better through simply asking for more broad-based input and taking it seriously. While lamenting that ‘We have lost self-confidence and ambition and the ability to recognise excellence amongst our own’¹, the manner in which the report appears to have been formulated so far reinforce precisely those tropes.

The Indian report itself seems to be a work in progress, rather than a completed document. One can thus hope that these and related issues will be addressed before it achieves its final form.

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3. <http://www.universityaffairs.ca/news/news-article/naylor-report-lays-groundwork-re-new-basic-research-canada/> (accessed on 18 April 2017).

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COMMENTARY

Science, profit and innovation

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‘A country without science is like a car without an engine: it’s not going anywhere’, mentioned an editorial in *Nature*¹. To scientists this may sound obvious, but in today’s world rational thinking matters less than ideology and prejudice. A significant part of the global population has little trust in the elite, and scientists as a social group are perceived thus². One reason for this may be the silence of the scientific community on the political economy of a world view that has brought the world to its present state. Contrary to the title of a much hyped book of the early 1990s, the disintegration of the former Soviet Union, did not result in the end of history³. Nor did aggressive ‘state capitalism’ in China play a part. Rather, financial globalization and the myth of an all-knowing market economy got a huge fillip.

For more than 20 years private capital, legitimate and illegitimate, moved across national boundaries with unprecedented ease. Companies made profit by cutting down on labour costs and taking advantage of the loop holes of country-specific tax laws. This led to an overall loss of jobs, a many-fold increase in corruption, and heightened economic inequality the world over. The excesses of fictitious finance capital and the shadow banking

industries finally climaxed in the spectacular market failure of 2008 (ref. 4). Its full economic and political impacts are yet to unfold fully, but science and technology (S&T), both globally and in India, have not been immune to these profound changes.

The agenda and the interests that drive much of current S&T originate from an incomplete understanding, deliberate or otherwise, between ‘profit’ and ‘innovation’. Profit today means a safe and assured return on invested private capital. Innovation, on the other hand, is an economic abstraction that tries to contextualize the role of technology in the evolution of a capitalist society⁵. It basically means new ways of doing things that improve the quality of life, but not by breaking laws or inflicting hidden damages⁶. New ways of doing things that improve the quality of life require investment and involve the risk of failure. Profits generated by successful innovations are rewards sanctioned by society to the entrepreneurs and other stakeholders for their risk-taking abilities and successful efforts in lifting the economy to a higher level.

The market crash of 2008 was a rude wake-up call for the world as many of the ‘innovative products’ of the financial

world turned out to be fictitious. Several banks and companies that were household names came under the scrutiny of the regulators after the market crash. The banks that were ‘too big to fail’ had to be rescued by massive state intervention with tax-payers’ money. It also turned out that, to maximize profit, an astonishingly large number of reputed companies that boast of research and development (R&D)-driven innovations had manipulated, fabricated and suppressed scientific data and evidences.

Pharmaceutical giants such as Pfizer, GlaxoSmithKline, Johnson and Johnson, Merck, Abbott and Amgen collectively paid about 11 billion dollars in fines in the US courts. They were accused of ‘the intent to defraud or mislead’ the consumers. Novartis, the self-proclaimed champion of innovation, was fined 390 million dollars for granting kickbacks to pharmacies that recommended the company’s drugs in the US. In India, Novartis had gone to the Supreme Court to defend an ever-greening patent and lost. They had failed to present any evidence of a difference in the therapeutic efficacy between gleevec, a minor modification of a molecule that they wanted to patent again, and the raw form of imatinib, the original molecule patented years ago.

In the automobile industry, starting from 2010, Toyota and General Motors recalled about 40 million cars and paid about US\$ 2 billion in fine for ignoring safety-related issues. In 2015, Volkswagen was caught red-handed for using hidden or 'defeat' software to cheat in emission tests. Some of the diesel cars manufactured by the company emitted up to 40 times as much nitric oxide and nitrogen dioxide than allowed. Martin Winterkorn who was the head of R&D when the software was developed and had later become the head of the company, resigned after the scandal broke.

The claims for environmental and health-related damages arising from the infamous Exxon Valdez oil spill in 1989, was settled by Exxon in 2009 by paying a paltry half a billion US dollars. One of the primary causes for the oil spill had been Exxon's unwillingness to implement state-of-the-art iceberg monitoring software. Deep water oil spill by BP in 2010 was about 20 times the size of the Exxon Valdez spill, an insufficient safety system and a series of cost-cutting measures being the two main causes. In less than 10 years, BP and Royal Dutch Shell between them have been responsible for three oil spills, the last being as recent as May 2016.

Finally it has now come to light that Exxon had suppressed scientific data over a period of more than 40 years. The data had come from its own R&D and showed that increased levels of carbon dioxide from fossil-fuel burning would result in the melting of ice in the Arctic. As a result, Beaufort Sea would be ice-free for five months in a year instead of two. Exxon had used this knowledge to buy oil leases in these areas while publicly denying the seriousness of the threat of global warming.

The above-mentioned cases are only a few illustrative ones that show how big companies single-mindedly chased profits but not innovations over the last several years. Profit, as pointed out earlier, is not an entitlement but a reward for being innovative and benefiting society. In a democracy a complex network of institutions, collectively referred to as the ecology of innovation, is supposed to provide the necessary checks and balances and promote innovations.

Companies undertake R&D projects to improve product or service quality, or to cut down on the cost of manufacturing, or to hedge against technical competition

and obsolescence. The ecology of innovation is supposed to ensure that public interests are protected and platforms for converting inventions into innovations are in place. The global economic orthodoxy of the last several decades with its talk of a 'self-correcting market' allowed the regulators and the politicians to ignore these fundamentals. There is no evidence to show that well-funded scientific academies and institutions took much notice of these frauds in the name of science. The job to bring them to the attention of the public was largely left to a few maverick individuals^{7,8}.

Although industry took the lead in the chase for profit without innovation, many scientists and scientific institutions were not far behind. While reporting controversial results in peer-reviewed journals, some scientists with research funds from Industry conveniently chose not to report any conflict of interest⁹. The human genome project had come to an end on 26 June 2000 with much fanfare. Apart from ensuring generous research funds for biological sciences for years to come, much was promised in terms of biotech-based 'personalized medicine', new drugs for genetic disorders and even solution to the global energy problems. After 10 years, the status in 2010 was succinctly summed up as '*the hope ... that lots and lots of money would be made...certainly did not materialize*' (italics added).

Today the pursuit of 'lots and lots of money' has intensified many fold, but real innovations remain as elusive as ever. The University of California, Berkeley, and the Broad Institute of MIT and Harvard are engaged in a lawsuit that deals with patents related to the gene-editing technology based on CRISPR-Cas9. A vital component in almost all big innovations has been the collaborative spirit between scientists and academic institutions during the validation stage of a good idea. The real hard part, deal-making, patent lawyers, etc. comes when an invention has to be turned into a practical technology that works at least in the laboratory.

CRISPR is still at a very early stage of concept validation. To take it from a petri dish to something that works for a mouse, and then hopefully for human beings, is a formidable if not an insurmountable challenge. Unfortunately, in the pursuit of illusory profit, the collaborative spirit of science has already been

sacrificed and the fundamental educational missions of the research institutions have been compromised¹⁰.

Even research that has no potential application has come under the relentless pressure of profit motive and as a result, the quality of work has suffered. Science metrics – the number of published papers' impact factor of the journals, the number of times papers get cited, etc., continue to exert an overriding influence on the career progression of all scientists, and eventually create 'celebrities' in science^{11,12}. The publishing companies have never had it so good: most scientists want recognitions for their work and many of them want to be celebrities. So the industry makes more profit by publishing more journals and more papers. As Brian Nosek, a professor at the University of Virginia, USA and Director of the Center for Open Science wryly remarked, 'Academic publishing is the perfect business model to make a lot of money'.

The damage that this deluge of papers has caused to potential innovations is obvious. An alarmingly large portion of published papers are of such poor quality that they cannot be reproduced, and in some cases are deliberate frauds. This problem cuts across all disciplines. In the infamous Schön case of 2002, the journals *Science* and *Nature*, that pride themselves on their standards of refereeing, not to mention their visibility, published multiple papers in physics before the fraud was detected. In 2012, when attempt was made to reproduce 53 high-profile cancer research papers by independent researchers, only six were found to be reproducible¹³.

Innovation became a buzzword for politicians and policy makers the world over after the market crash of 2008. A new institute called 'European Institute of Innovation and Technology' was set up in Europe. Australia decided to have a 'National science and innovation agenda', and 2011–20 was declared as the 'decade of innovation' in India¹⁴. Both the past and present Prime Ministers of the country in their speeches to the Indian Science Congress of 2013 and 2015 respectively, used the word 'innovation' more than 10 times. Very recently the second edition of 'India Innovation Growth Programme' in which the Department of Science and Technology is a partner, was rolled out at no less a place than Rashtrapati Bhawan with the

lofty aim to ‘hand hold and incubate promising innovations’¹⁵. However, there is no evidence to show that in India, barring the pharmaceutical sector, the private sector has any real appetite even for incremental innovations. A top-down approach and talks of public–private partnership may be good for profit and public relations, but unlikely to deliver genuine innovations.

A more promising approach would be to ensure that our specific innovation goals are set from a position of knowledge, free from any conflict of interest, and supported by civil society. The urgent need for India-specific innovations in the health and agricultural sectors cannot be overemphasized. The big international pharmaceutical companies remain focused on profiting through increased pricing. Their attempts through litigation to prevent and delay the entry of affordable drugs, even the ones listed by WHO as essential medicines in the Indian and other developing world markets, show no signs of stopping. The lobbying for genetically modified agricultural crops also continues and many ‘experts’ refuse to recognize the basic conflict-of-interest issue^{16,17}.

The Supreme Court of India has so far interpreted the patent, environmental and other laws keeping the interest of the vast majority of Indians in mind¹⁸. Future India-specific innovations in the pharmaceutical sector would be critically dependent on such judicial support. Good science does not necessarily mean

profits, or a product or technology that delivers societal benefits. In contrast, innovation does require scientific objectivity, attention to detail and transparency. This is especially true when the entire regulatory system is suspect and the people who are supposed to benefit belong to the weaker sections of the society.

During the heydays of globalization it was correctly observed that ‘To prosper, we need an international process that can, time after time, fundamentally rethink the elements of our innovation ecology’¹⁹. A truly ‘international process’ becomes acceptable to the ordinary people of any sovereign country only when benefits and increased prosperity are accessible to them through more jobs, less inequality and deeper democracy. So long as private capital remains focused only on profit, with the political class paying lip service to innovations and sustainability, and scientists remain mesmerized by science metrics, profit will continue to be the end result of most scientific endeavours.

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