

‘Nano Scale’: Society’s Deep Impact on Science, Technology and Innovation in India. Pankaj Sekhsaria. Authors Up-front. 2020. 182 pages. Price: Rs 495.

Before reading this book, I had the privilege to attend a lecture by its author, Pankaj Sekhsaria. It was a lecture on an unusual topic. Sekhsaria mentioned about few issues that are never spoken about in public. He has elaborated these in detail in this book. It is so well written and clear in the exposition of issues we face in India, that one can rethink on some government policies to see how they can help build a high-tech industry in the country on the one hand and also depicts what hardship Indian researchers face. It is high time that India develops the high-tech industry and does not keep importing high-tech items. This book is sort of an eye-opener.

It has come at the right time when this debate of ‘Make in India’ versus ‘Import in India’, etc. is going on. Sekhsaria considers many cases here involving nanotechnology applications. It starts with an instrumentation for nanotechnology and goes on to the use of nanoparticles to solve typical Indian problems like water purification for clean drinking water, or difficult global issues like the cure for retinoblastoma cancer. But this book is not a simple reporting of case studies; it makes deeper comments on the overall society’s role in innovation and science–technology development. All the cases mentioned in the book shed light on how crucial it is to have specific culture in the laboratories or institutions to develop innovative ideas and technology leading to good science. It also shows the men and women who worked or/are working hard to achieve certain goals and how

society’s values and culture shaped their careers, successes and failures.

I am more interested in discussing the case of the Physics Department at Pune University and the development of a pure Indian version of the STM machine built with ‘jugaad’, a typical Indian way of making things work. Sekhsaria nicely takes us along with him on the entire journey of the progress of STM development. I was a student at that time in the Physics Department of Pune University; so all the events he describes actually happened in front of my eyes. We, as M.Sc. students, had to visit these laboratories and perform experiments. We were also shown different instruments which were state-of-the-art at that time and had the opportunity to use them to perform experiments. This was unthinkable in the scenario of university education back then in India and even now, but we were lucky that then we had people like Dharmadhikari (his case is described in detail in this book and so I have mentioned his name) and his equally competent colleagues, who had built these machines indigenously. Since the equipment were not imported, they could be handled by students and we could get first-hand experience of using such high-tech instruments. This training played a major role in our future careers as well. Also, these machines were quite robust, which is also part of the ‘jugaad’ culture developed in India over several decades. Sekhsaria explains about jugaad and how it has helped Indians think innovatively (Complete details are in his book *Instrumental Lives*, Routledge Pub., ISBN: 9780367856298).

It is unfortunate that the culture at that time, and even today, about just publishing papers and doing science without thinking of commercializing the developed high-tech instruments, has resulted in stalling any progress of high-tech industry in India. In retrospect, if Dharmadhikari or any of his students would have been supported by Government or venture capitalists, they would have developed the Indian STM machines as products and we would have had our own Indian version of the same. However, it did not happen and Sekhsaria explains this, blaming it on the culture and expectations from society. The socialist or egalitarian thinking may have lead to this kind of debacle. It also shows under how meagre support, such high-tech instruments could still be developed and work

could get published in high-impact journals that time. Towards the end of the book, Sekhsaria revisits Dharmadhikari laboratory and realizes that it is going to be closed since the real-estate Dharmadhikari laboratory was occupying, would be taken over by some other new recruit in the department. The machines and instruments indigenously developed will be junked, thus putting an end to the historic achievements. Sekhsaria makes an important point here about the status of such instruments which have historic and educational value. In fact, these instruments can be donated to local colleges, so that they can teach the undergraduates about them. This is possible in USA, as many of the instruments, sometimes state-of-the-art ones too, are up for sale at throwaway prices, when laboratories or companies close their projects. For example, Scanning Electron Microscope (SEM) which is non-working may become available for just US\$ 2000 and if any bright enterprising student can repair it, the machine can be used. This has been done in USA. People have used such instruments to do lithography in their (home) garage. We do have equally talented kids in India. However, this kind of culture is lacking in the country.

Sekhsaria also mentions about Ayurvedic medicines like bhasmas and modern nanotechnology. Here again he explains beautifully the two different worlds of modern medicine and ancient Indian medicine. It is obvious that the language used would be different as Ayurveda is mainly naturopathy, while modern medicines are chemicals. Even the diagnosed causes for disease are different. This is expected since Ayurveda is based on symptoms classification of kafa, vata and pitta, and any diseased person would have some combination of these basic symptoms. However, he gives examples in the Agharkar Institute, Pune, about the language conflict between modern medicine and Ayurveda for communicating ideas or the reasons for symptoms or cure. The scientists are demonstrating how using modern technology, nanoparticle nature of chemicals in bhasmas has helped cure some diseases.

Sekhsaria also uses this theme to describe that employing nanoparticle technology, especially silver nanoparticles, we can purify water at a much cheaper cost in India. But again, culture can play an important role in making this either a success or failure. He shows that

how this business venture failed in Hyderabad and places around it since, to begin with the technology used was that of the filter candle. With modern technology of UV light-driven tubes, it will not be possible for any of these candle-based purifiers to compete and survive. Also, with LEDs and LDs of wavelengths below 350 nm, that can kill viruses, it is imperative that any society with access to electricity would not want to invest in candle purifier technology. The electric UV light-driven purifiers can be made compact also. This would put an end to the silver nanoparticle-based candle product. Sekhsaria describes this episode of candle based purifier technology development by a businessman. How he works hard to market it, but fails due to society's unacceptance as these filters are out of fashion. This leads to the product failure, although the product was nice. It shows how society's status ideas and culture can make or break a nice product.

Lastly, he touches upon one of the harshest social realities in India. The treatment of a girl child with retinoblastoma. At present, this disease is curable if the eye can be surgically removed. However, he finds that the parents would let the girl child die rather than give her proper treatment, giving the reason that no one will marry one-eyed women. Some of the most disturbing cases are described in the book. If nanotechnology can be used to cure this type of disease, it would be a boon to such patients. But in the quest of this nanoscale phenomenon, Sekhsaria hit upon this harsh reality and describes how social values and culture can decide treatment decisions, for the patient.

The book describes many cases in detail, but the most important point it makes is about the culture we have in India, mainly driven by poor economic conditions leading to scarcity of resources, and then some people still doing innovation. However, to compete and survive in the modern world and make usable and reliable products, it is not possible to continue with this type of jugaad culture, India has to change its policies and bring in innovation and encourage entrepreneurship.

Overall, the book is readable and enjoyable. It is an eye-opener in some aspects and looks at things in a different perspective. Most books till now on science or science-related matters have not looked at the social aspects of innovation that leads to successful or unsuccessful

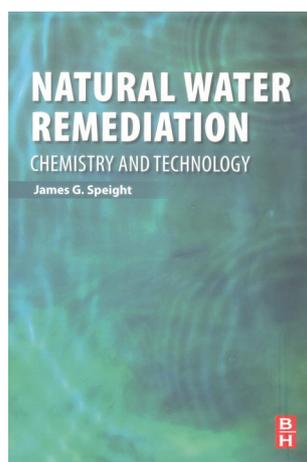
scientific programmes or products. Our old wisdom tells us that scientific research and technological innovation bring drastic change and society has no option but to constantly adapt and to evolve in response to it. This book gives a new perspective to look at innovation, science and technology development, and how society responds to it. It will be useful for Government policy to make suitable changes so that people do not rely only on jugaad type of innovation, but can actually get access to the complete modern technology, instruments, etc. and can design new machines. This will train the next generation of students, scientists and entrepreneurs. It is simply impossible to buy state-of-the-art equipment for every educational institution and get students trained.

In all, reading this book and listening to Sekhsaria's lecture has been a great experience and I encourage more readers to do the same. Please click on the following link to hear the lecture.

<https://youtu.be/RxkNEtdQcO4>.

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Natural Water Remediation: Chemistry and Technology. James G. Speight. Butterworth-Heinemann, an imprint of Elsevier, The Boulevard, Langford Lane, Kidlington, Oxford OX 1 GB, United Kingdom, 2020. Xii + 380 pages. Price: US\$ 120.00.

This book written by a well-known authority as a handy resource and reference book for engineers (environmental, civil and chemical) is a valuable and timely resource for researchers, practitioners and students as well. Water remediation is a hot topic now as water availability globally is finite. Water is considered as the elixir of life – without good quality available water, survival of human beings and other life forms is not possible. With the growing population of human beings (7.8 billion in 2020 and expected to reach 9.9 billion by 2025) and animals (1.4 billion livestock population) per capita water availability is declining steadily. Access to water particularly in the Asian nations, is becoming a big issue due to physical scarcity. In Africa, water scarcity is largely due to poor economic development, and not due to physical availability. The Third World war will be for water and the severity of the issue is evident every day in the media – many a times becoming the point of friction amongst neighbours (houses, villages – upstream and downstream, states/provinces and neighbouring countries) sharing water resources, thus disturbing the social fabric of the society through continued disputes for water. Countries in the tropics face the double challenge of managing water as evapotranspiration demand is far higher than the precipitation. Countries like India face the challenge of water scarcity as maximum (65% globally – varies with countries, e.g. India 80%) consumptive water use is for agriculture to ensure food availability for the ever-growing population. Also, with increasing incomes, the food habits are changing with more people shifting to animal-based diets, which has higher water footprint (15,000 l/day/person against 4500 l/day/person). As evident in India, groundwater use with 23–24 million borewells is directly associated with increased food production and increased industrialization. As a result the quantity and quality of water (surface and ground) are becoming a major issue threatening sustainable development. Along with increased demand for freshwater, the quality of natural water (surface as well as groundwater) is an issue due to increased pollution of rivers, seas and oceans as well as groundwater resources. With these challenges in hand, globally people are looking for solutions to adopt integrated water resources development