helm. The efforts to make it a vibrant research center are described at length. Good workshop facilities, bright and hard-working research scholars as well as the import of a few instruments and chemicals made IACS the premier research centre in physics in India during this period, though Raman had an ambition to take it to international levels. Again almost every statement is made with a citation of the source from which it is taken, leaving no doubt about the veracity of the remarks.

The last quarter of the book discusses the situation of Raman with reference to the Calcutta University and IACS. It must be a revelation to many that to the very end there was a very friendly atmosphere of mutual respect and support. Raman even espoused the use of Bengali language to teach youngsters, taken up vigorously later by people like S. N. Bose and others. In spite of the financial difficulties, Raman was supported to the extent possible and Raman reciprocated by crediting the University and IACS for the success achieved. Alas, Raman's outbursts on other workers, without realizing the deep hurt such remarks create, slowly made a group of people to be unfriendly. Raman's salary in 1928 was Rs 1000 p.m. and this was sought to be made Rs 1500 p.m. after the award of the Nobel Prize in 1930. There was a bitter and acrimonious debate with personal tirades in the Senate of the University and only the intervention by the Vice Chancellor enabled the salary increase. At about the same time there were feelers to attract Raman to the Directorship of the Indian Institute of Science, Bangalore, as the first Indian to be the Director. The challenge of Bangalore was tempting and tantalizing. The author clearly does not want to spend much time on this unhappy last years in Calcutta and merely quotes Raman's student, Sukumar Chandra Sirkar, 'Professor Raman was given an increment of Rs 500 per month after the award of the Nobel Prize and he was drawing altogether Rs 1500 per month at that time. The salary offered to him in Bangalore was about double this amount. He told me that he would take one year's leave without pay and during this period the work in the Association would be continued undisturbed'. Raman moved to Bangalore in 1932 and such was his unquestionable greatness that within a year he produced another world class gem from Bangalore, namely the Raman–Nath theory of diffraction of light by ultrasonic waves which explained at one stroke the bewildering changes of the intensity of the light diffracted when the ultrasonic intensity is varied and which has become the corner stone of the modern acousto-optic modulator instruments.

What else can one want? Another historian to tell about Raman's life before 1920s. The facilities of IACS and the Calcutta University were far below par and yet Raman managed to accomplish world class work in acoustics, specially the music of violin and drum (mrudangam). The article in *Handbuch der Physik* and the election to the Fellowship of the Royal Society were largely due to the pioneering work in musical acoustics. Recall that in 1924, the year he became an FRS, his light scattering work was not yet of the first quality.

History is replete with numerous examples of poets, musicians, and scholars who were living in abject poverty and yet produced work which are remembered even today as world class standing the test of time. This is a tribute to their genius. It would be terribly wrong to deduce that poverty is a necessary condition to produce pioneering work. Ramanujan was a mathematical genius. It would be a blunder to conclude that everyone who fails in the college examinations would become a great mathematician. Raman's story is similar. The conclusion to be drawn is merely that in a laboratory whose facilities were nowhere comparable to those in the top institutions elsewhere in Europe and USA at that time, a fine piece of research was produced. It is definitely not to indicate that substandard facilities in Indian institutions would somehow produce magical wonders.

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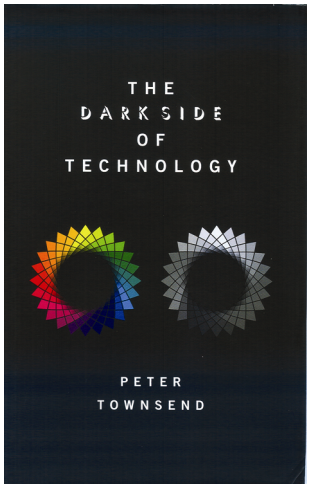

The Dark Side of Technology. Peter Townsend. Oxford University Press, Great Clarendon Street, Oxford, OX2 6DP, UK. 2016. xi + 306 pages. Price: £25.00. ISBN: 978-0-19-879053-2.

Right from the time of the Industrial Revolution it became clear that technology was not all good and that it had another side. No doubt thanks to the early technologies – textiles, iron and steel, transportation (steam engine, steam ships, railways, etc.) – productivity increased, drudgery reduced, income levels improved and rural communities were transformed into urban neighbourhoods. But, as social historians would tell us, it was only the rich and the middle class who started enjoying a better quality of life; for the working class life became more difficult. Technology also led to exploitation of labour (long working hours in poor and unsafe conditions, for example) and industrial disputes as was illustrated by the Homestead strike at the Carnegie Steel Company in Pennsylvania in 1892. The social dimensions of today's technologies, e.g. information technology and biotechnology, are far more serious than those of the earlier technologies. In this book, the author aims to show how science and medicine have altered our lives.

Take nuclear energy for example. While it is clean and it accounts for about 11% of energy used worldwide, it also has a downside. For example, disasters at Three Mile Island, Fukushima Daichi and Chernobyl caused untold suffering. Today nine countries including India possess nuclear weapons, and a mad rush of blood in the leader of any of these countries can lead to global devastation. After the recent standoff

between Trump and Kim Jong Un, the hand of the Doomsday Clock of the *Bulletin of Atomic Scientists* was moved to two minutes to midnight. Nations today are also capable of waging chemical and biological warfare which has not been, thankfully, field tested so far. There are other weapons of mass destruction and they may fall in the hands of terrorists. Astronomer Royal Lord Rees worries if the human race will survive the 21st century.

While chemical companies produce many essential materials, they are a potential source of disasters, witness the Bhopal tragedy of 1984 when a Union Carbide pesticide plant leaked tonnes of poisonous gases and killed thousands of people and injured many more and the explosions at the Phillips Petroleum Company plant in Pasadena, Texas in 1989 killed 23 people and injured more than 300.

Great strides have been made in medicine. With a host of vaccines and antibiotics, modern medicine has saved millions of newborns and infants from childhood mortality and adults from serious diseases. Smallpox has been fully eradicated, leprosy and polio are virtually eliminated, and we now have vaccines for measles, diphtheria, whooping cough, rubella, mumps, tetanus and rotavirus. If the global average life expectancy at birth has risen from well below 30 till 1870 and below 50 in 1900 to much above 70 today it is largely because of advances in medicine and agriculture. But for developments in agricultural technology we would not have been able to feed the 7.6 million people on planet earth. There is another side. Multinational drug companies are selling dubious and unapproved cocktails of antibiotics, all of which could spur the development of drug-resistant bacteria and imperil patients and pose a risk to global health and undermine efforts to control drug resistance, says a recent report in the *British Journal of Clinical Pharmacology*. Antibiotics are also increasingly being used irresponsibly in farms raising poultry, pigs, cows, turkeys and chickens endangering human lives.

Computers and cell phones coupled with the Internet and WiFi have revolutionized the way we access information and communicate. Internet Archive, Digital Public Library of America and Europeana have made it possible for anyone anywhere to read most books ever written, see most paintings, sculptures and films ever made, and listen to a huge volume of music. Scientists now have online access to full texts of more than half the research papers published. Indeed a great boon, one would think. But consider the other side. The volume of unsolicited messages, many from fraudsters, is estimated to be over 75 million a day. People are not only tracked by tech companies like Google and Facebook but are kept under surveillance by their own governments. Our privacy is eroded. Google and Facebook are pointing their supercomputers at children around the world making them addicts and depressed, says Tristan Harris, a tech ethicist and co-founder of The Center for Humane Technology. Harris and friends have launched 'The Truth about Tech' campaign to teach students, parents and teachers about the troubling side effects of too much tech use. British Parliamentarians believe that the disinformation campaigns and false news reports that have affected elections and society in the US, Great Britain and elsewhere had originated in these companies. People are becoming addicted to these devices and the time they spend with family, friends and colleagues has diminished.

The new sensation in computing is algorithmic trading – proprietary computer programs that can perform thousands of trades in a second. Here is a recent headline: 'How high-speed trading fuels Wall Street disasters: Computer algorithms swap thousands of stocks each instant – and could set off a financial meltdown'. Indeed, a rogue code in an algorithm before it could be identified and corrected caused a trader the loss of millions of dollars in minutes. Far more serious could be a disaster triggered by intense sunspot activity crippling the world by destroying communication satellites and power grids.

In the chapter on revisiting Silent Spring, the author devotes much space to food and food technology. It is especially important when 'food is becoming a geo-political tool again. The blend of GMOs, intensive links between commodity exchanges and peasant production and increased monetization of food trade can cause huge perturbations in a very short time', says a former CGIAR scientist.

Even advances in transportation technology could have a dark side, as was evidenced by the spread of Severe Acute Respiratory Syndrome (SARS) in 2003 from a remote village in China to other parts of Asia, Europe and Canada within days thanks to infected air travellers carrying the virus.

Both experts at McKinsey & Company and a potential presidential candidate in the US believe that automation could lead to massive unemployment. And the loss of jobs could lead to violent unrest.

For every Daedalus there would be an Icarus who perished in the sea because he crossed the safety limits in the use of technology. He flew higher and higher and the Sun's heat melted the wax holding his wings together.

Townsend's book is different from Brad Huddleston's book of the same title. While both of them emphasize the need to be cautious in the way we use technology, Huddleston, with his straightforward Biblical approach, appears to place the blame entirely on the shoulders of humans: 'Ultimately, the problem is not technology. The problem is darkness. Computers and phones do not cyberbully, consume pornography, send 500 text messages a day or commit online adultery. People do. And people who don't understand the risks are falling every day'.

Townsend believes technologies have brought us immense progress and wealth, but simultaneously are sowing the seeds of our destruction. Fortunately, some people are recognizing the dangers and with proper action we can save ourselves. His is a message more of hope than despair.

As Lord Rees has said science and philosophy should guide today's youth in creating a more sustainable world.

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