Three Phases of Popularization of Science in Colonial Bengal

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Rammohan Roy and Popularization of Science

Raja Rammohan Roy, Father of Indian Renaissance, was also the fountainhead of Popularization of Science in India. This stemmed from his inherent spirit of rationalism.

It was he who wrote the letter to Lord Amherst in 1823 praying for allocation of Rs.1 lakh earmarked for native education, for the purpose of the promotion of Natural Science. He argued that India was already well up in logic, philosophy and literature for material improvement. She badly needed the knowledge of science. The money could be spent for running courses in physics, chemistry, mathematics and life sciences; well equipped laboratories should be set up and qualified teachers could be brought from England for instructions, but the Government did not pay heed to his appeal. It was a cry in the wilderness. But Rammohan was dauntless; he himself wrote scientific treaties on geography, astronomy and geometry for the School Book Society around 1828. In 'Sambad Kaumudi' published by him in 1820, he wrote such marvellous scientific essays in Bengali as 'The Eyes of the Fish', 'Light of the Stars', 'Echo', 'Property of Magnetism' and 'Description of a Balloon'. He made a nationalist critic of the precepts of Jesus and wrote scientific treaties on monotheism. He rationalized Hinduism in the form of a new creed to be called Brahmism and published the essence of the Upanishad. Thus he set the scientific temper of the age.[1]

Dr. Mahendralal Sircar

The Second phase of popular science begins with Dr. Mahendralal Sircar. He was the founder of the Indian Association for the Cultivation of Science in 1876 and through this institutions he propagated popular science.

The Constraints of Colonial Science

Dr. Mahendralal Sircar, the doyen of cultivation of science in India was born in 1833, the year of Raja Rammohan Roy's death. Mahendralal was truly the torch-bearer of Rammohan. He implemented what Rammohan advocated for scientific education in 1823. The pursuit of science and technology during his time was completely in colonial interest and had very little to offer to Indians for their indigenous aspirations and needs. The Asiatic Society (1784), Botanical Gardens (1787), Agri-Horticultural Society (1826) and the Medical College (1835) were all institutes of science but their main objectives were to acquire knowledge about Indian land and people, flora and fauna, religion and culture, health and hygiene to be used as inputs for better colonial administration and extraction of wealth. Michel Foucault in his Archaeology of Knowledge and Order of Things has marked out the evolution of various disciplines because of social and state requirements.[2] The colonial government in India also carried out various official surveys starting from land and land revenue survey to geological and anthropological surveys during most of the nineteenth century. All these surveys involved considerable science and technology but this was not reflected in the syllabi of the government schools and colleges. The later were the strongholds of humanities. Medical education was promoted mainly for the healthcare of the ruling class, and the hospitals mainly catered to them. Rammohan had noticed all these developments and on 11[th] December 1823, he wrote his famous letter to Lord Amherst pleading for scientific education. The Government had then decided to spend Rs.1 lakh for improvement of education, and the Anglicists and Orientalists fought bitterly over its allocation in their respective areas of interest. Rammohan in that letter strongly opposed the establishment of a Sanskrit College and promotion of Sanskrit learning with this fund and strongly recommended its spending for studies in mathematics, physics, chemistry and other natural sciences with the help of duly qualified staff, suitable laboratories and books. He was not against Sanskrit lore but he thought that India was well equipped in this branch of study and needed scientific education which it totally lacked.[3] But Lord Macaulay's Education Minute in 1835 decided educational policy and expenditure in favour of humanities and English education. The new course had only elementary science in it. The colonial government had no intention to make India self-reliant by training Indians in science and technology. England had already staged Industrial Revolution and therefore wanted India to consume her manufactured goods and supply raw materials to her factories. Shivnath Shastri in his *Ramtanu Lahiri o Tatkalin Bangasamaj* (Life and Times of Ramtanu Lahiri) clearly exposes the elementary level of scientific instruction at the Hindu College. He describes how Dr. Tytler, Professor of Chemistry was nicknamed Soda Sir by his students for whiling away his time on explaining the properties of soda.

But the Government was not alone responsible for it. The elites of that time also wanted to learn English alone and delighted in reciting from Shakespeare, Milton, Byron and Shelley. This was their passport to official patronage and ultimate employment. The scientific temper was sadly missing.[4] Mahendralal passed the Matriculation Examination from the Hare School with scholarship in 1849 and entered the Hindu College which had the same Anglophile ambience. The scientific and mathematical genius of Mahendralal could not be satisfied with it. He left the college after a few years to the surprise of his classmates and despair of his teachers and well-wishers to join the Medical College in 1855. The Medical College had genuine research-based science curriculum in those days. It has well here, he obtained LMS in 1860 and MD in 1863, second after Chandra Kumar Dey, the pioneer.[5] He could have obtained at best the post of Sub-Assistant Surgeon in the Public Health Department on merit. The famous pioneer of dissection and medical practitioner Pandit Madhusudan Gupta could not proceed further than this in his career. The Indian Medical Service was the monopoly of white physicians. Mahendralal, therefore, did not join this subordinate service and set up his own practice instead to become its topmost practitioner. Of the England returned medical graduates, Dr. Surya Kumar Goodeve Chakraborty took the initiative of setting up a branch of the British Medical Association in Calcuta. Mahendralal first became its member and later its Vice-President. In his first lecture before the Association, he ridiculed homoeopathy as quackery, but surprisingly enough, he changed his opinion afterwards and became an eminent Homoeopath himself. He himself states that he got Morgan's *Philosophy of Homoeopathy* for review from the *Indian Field* and on reading it, he gave up his hostile attitude and became drawn to it. To know more about its practical aspects, he began visiting the chamber of the famous homoeopath Dr. Rajendralal Dutta and was profoundly impressed by his medical success. In 1867, he reversed his earlier apathy towards homoeopathy in a lecture before the British Medical Association and pointed out the uncertainties and insecurities of allopathic treatment. This enraged the famous Allopaths of the day - Waller, Ewert and Surya Chakraborty, and they ganged up against Mahendralal to frustrate him. He himself has described his suffering for the sake of truth. Rumour spread that he had lost his faculty and had become a slave of quackery. He was equating part with the whole. His regular patients lost their faith in him and began leaving. His practice was ruined and he did not get a single patient in the next six months. Even those who used to come for free treatment and medicine insisted on old prescriptions but Mahendralal was indomitable. He launched the *Calcutta Journal of Medicine* in the columns of which he carried on his crusade for homoeopathy. He soon built up his practice in the new field as well. The constraints of colonial science and the hauteur of the wardens of Western medicine moved him to stage this revolt. He began looking out for an institute for independent pursuit of science.[6]

The Nationalist Pursuit of Science

Mahendralal first thought of a National Institute of Science in 1869 and began appealing to the public through various pamphlets, letters to the *Hindu Patriot* and lectures in public meetings. In his first public lecture in 1869, Mahendralal set forth his arguments vigorously in favour of such an institute :

"The kind of knowledge which is best calculated to remove prejudice and the spirit of intolerance from the mind is what passes by the name of the physical sciences. And the reason for this lies in the fact that in the pursuit of these studies there is little room for dogmatism. We are certainly at liberty to advance opinions and hypothesis... but we have no right to urge them as facts until they have been verified so that whoever questions their correspondence with nature can at any time satisfy him by observation and experiment. The world is yet being largely governed by the despotism of traditional opinions... but nowhere is this despotism of traditional opinions more severely felt than in this country. The Hindu religion, besides having in a pre-eminent degree, the grand characteristic of all religions, which is to divorce the mind from the works of God, has besides become through the corruption of successive ages, a heterogeneous medley of theology, philosophy, science, and what not. In other words, a chaotic mass of crude and undigested and unfounded opinion on all subjects, is enunciated and enforced in the most dogmatic way imaginable... While the British nation has a duty to perform towards us, it must not be forgotten that we have no less solemn and sacred duty towards ourselves, imperative patriotic feelings for the land to which we have the honour and the pride to belong. It is true that born in India we have inherited submission to a foreign yoke but it must be our consolation that we have inherited a mind not inferior in its endowments to the mind of any nation on earth ...Though regeneration of the people of India will of course, be the work of time and of favourable circumstances, it is in our hand if we will but have it.

We want an institution which shall be for the instruction of the masses, where lectures on scientific subjects will be systematically delivered and not only illustrative experiments performed by the lecturers but the audience should be invited and taught to perform themselves. And we wish that this institution be entirely under native management and control. We say this not out of vanity but simply that we may begin to learn the value of self-reliance in matters in which we may do it without any serious risk."[7]

In this lecture Mahendralal wanted to inspire scientific outlook among the masses and with that to eradicate superstition and dogmatism. He fondly believed that this would arouse the masses and make them self-reliant even under colonial rule. In another lecture, Mahendralal stressed the need of a national institution for the specific reason that the colonial government was not willing to impart the scientific education to the masses; I say with deep regret that our government has hitherto afforded no opportunity nor afforded any encouragement to the pursuit of science by natives of this country.

He was worried about the nature of superficial scientific education imparted in government colleges and universities where there was no provision for practical work to support such instructions. The public was ignorant of the applied side of sciences. He, therefore, wanted to set up a normal school, a training academy by natives to provide science as well as scientists for nation-building purpose. Mahendralal got some unexpected opposition from his own countrymen in this regard. The fundamentalist orthodoxy opposed him for fear of subversion of religion and spread of heresy. Mahendralal tried his best to reconcile religion to science in a lecture entitled 'Moral Influence of Physical Science' delivered in January 1891 at the Town Hall. He argued that the two were not exclusive terms. Science was essentially a search for Truth, the First Cause, the discovery of the unity of nature and rhythm of the universe. It made one more moral and godly and aware of the Almighty. This was a fixed tenet for Mahendralal in his private life.[8]

The toughest opposition came from the leaders of the Indian League who wanted science to be utilised for improvement of comforts of life instead of cultivation of general science. They wanted employment of the unemployed and production of consumer goods and a Mechanics Institute to promote both. Mahendralal tried his best to convince them that his proposal was not contrary to his critics' project. If a generation of theoretically and practically trained scientists was not produced, who would train the mechanics of the town and the country? His National Association would train the first batch of scientists of India for national reconstruction. The leaders of the Indian League, Rev. Krishnamohan Banerjee, Shambhuchandra Mukherjee, Motilal Ghosh et al. projected their Albert Mechanics Institute to mark the visit of the Prince Consort and thus to get official support for their new political party. In association with the name of the Lieutenant Governor Richard Temple, the Ghosh-Temple League was notorious during that time. Under the pretext of providing popular science, the League wanted to curry favour with the government to earn political recognition of their newly founded party and sabotage Mahendralal's project of a National Institute of Science. Though some writers have tried to justify the more practical purpose of the Albert Institute, there was no noble intent in their enterprise. In the monster meeting at the Senate Hall in 1876, the great Brahmo orator Keshub Chander Sen and Father Eugene Lafont eloquently argued why the National Institute should be more effective and popular in the long run. The Government finally accepted Mahendralal's proposal and gave it financial and administrative support. Mahendralal had resolved that his countrymen should bear its expenses to make it a national institution. He appealed to the native princes, zamindars and wealthy people and invested his own savings. He got unprecedented response to his call for donation. Joykrishna Mukherjee, Raja Kamal Krishna Deb, Digambor Mitra, Jogeswar Singh, Pandit Iswarchandra Vidyasagar, Maharaja Jatindra Mohan Tagore, Dwaraka Nath Mitra, Maharaja of Patiala, Dwijendra Nath Tagore, Gunendra Nath Tagore, Judunath Mallik, Maharani Swarnamayee and others together raised one lac forty thousand rupees.

Popular Science

We can refer back to the previous debate between Science and Technology in this context of popular science. In that meeting, the President of the Indian League, Rev. Krishnamohan Banerjee said in favour of their Mechanics Institute :

"The first condition was that the proposed college was to be considered as commemorative of the condescending visit which His Royal Highness, the Prince of Wales paid to India and therefore it must bear a name suggestive of that idea. The second was the combination of scientific teaching with practical training... the one being based on a feeling of loyalty which would not be allowed to be interfered with. The other was indicative of desire on the part of their subscribers to help in associating a feeling of personal independence with acquisition of knowledge and the attainment of university degrees and honours. No one could tell the day with greater favour than himself if that scheme could give rise to Indian Galileos, Indian Newtons, Indian Herschels and lead to discoveries of new stars called by Indian names, new theories designated by Indian vocables, new terms couched in

Indian language... Existing circumstances compelled him and his friends to think of utilising the discoveries already made before aspiring after such discoveries."[9]

It is evident that the loyalists were unable to welcome Mahendralal's National Institute of Science and its attempts to become self-sufficient. On the contrary, they wanted to strengthen their political organisation through official patronage by sacrificing the cause of the National Institute. If technical education was the main goal for popular science and sustenance, that would still have been a popular scientific resolution. But it was only a pretext for political aims. Even to promote technical education for bread and butter, Mahendralal's proposed institute was the only way. In a speech on 4th April 1875, he explains it himself :

"One of the greatest obstacles to the introduction of science into our schools and colleges is the paucity of indigenous teachers. Now the institution such as I want with your aid to establish will in time furnish abundance of teachers and thus be a great help to Government carrying out its purpose of diffusing a knowledge of science .... The sole function of the Association will be pure science learning and science teaching apart from all bread and butter .... There is at present a sad deficiency of scientific culture amongst our countrymen, the deficiency as has not been and can never be met in schools, even if the utmost efforts were made by the government for the most efficient teaching of science in these schools. In schools people can never rise to the state of practical workers so as to be able to carry on independent investigations not because of any fault in the psychology of pupils themselves but because such a thing is impossible in *statu pupillaris*........ Now, gentlemen, for want of such men here, Government has to bring out men from England, whenever any necessity arises for carrying on investigations in any subject and even for professorships in its educational institutions. Whether, when our Association will be able to furnish such men, Government will accept their services, I cannot venture to say but then there will be at least no excuse for Government to order out men from England at necessarily heavier expenses."[10]

In other words, Mahendralal wanted to get rid of English instructors to teach pure science or even technology and create our own personnel. In 1876 Rev. Eugene Lafont supported Mahendralal in that historic debate to decide the fate of the National Association thus : "The Scientific Association was not intended to produce Newtons, Galileos and Herschels, though even that was not impossible but its primary object was very different and much more practical... The other Association wanted... to transform the Hindus into a number of mechanics requiring for ever European supervision whereas Dr. Sircar's object was to emancipate in the long run his countrymen from this humiliating bondage."[11]

Rev. Lafont's exposure of Krishnamohan's pretence for popular science and his support for Mahendralal's Association enabled the later to get official recognition of the League at that time. Siddhartha Ghosh in an essay upholding the cause of independent pursuit of technology has played up the League's efforts in this regard and played down Mahendralal's Association as a stumbling block. The above should settle the debate. Mahendralal had not opposed the spread of technical education but had actually worked for its spread in many of his lectures on popular science and writings in the Dawn Society's magazine in his later life.[12]

Popular Science and the IACS

In the draft proposal of the IACS, it was clearly stated : "The object of the Association is to enable the natives of India to cultivate science in all its departments with the view to its advancement by original research and as it will necessarily follow with a view to its varied application to arts and comforts of life."

Mahendralal saw in his own life that except for the medical schools, there was no provision for teaching practical science in any other institution. It was not enough to know the principles and practices of science. One had to work with dedication in scientific research and Indians could do it in keeping with that tradition. In a previous lecture he had already denied that he was trying to set up an association like Sir David Brewster's British Association or Count Rumford's Royal Institute. He pointed out that there was no dearth of scientists in that country and the need was how to accelerate original research and spread science among the masses. He had no such high ambition to set up a parallel institution in the Indian context. But he had firm faith that once established, it could reach that target in time. In the draft proposal therefore some basic sciences were proposed to be taught, i.e., physics, chemistry, astronomy, botany, biology, physiology and geology. Graduates from colleges and especially Medical College were to be recruited to man these departments and specialists were to guide them. Trained in this way, the budding scientists would be able to lecture on their respective subjects and undertake fundamental research. He expected this training to be over within one year and two series of lectures were to be arranged by them, one for the people and the other for the advanced people. Thus popular science would spread among the masses and it would not be impossible to produce scientists in lakhs.[13]

In the series on popular science, Rev. Lafont alone delivered the maximum number of lectures from 1876 to 1893 on Light and Sound. He gave twenty to thirty lectures each year. Dr. Sircar himself also gave lectures in this series for a long time and his subjects were Electricity and Magnetism. He also lectured on Heat for some years. From the annual report of 1891 it is found that Mahendralal gave twenty lectures on Electricity in that year. Jagadish Chandra Bose also gave lectures from 1885 on Electricity, Magnetism and Heat like Mahendralal. Asutosh Mukherjee also joined in 1887 and lectured on physical aspects of Light till 1890. Kanailal Dey first took his classes in Chemistry. He was succeeded by Ramchandra Dutta, Rajani Kanta Sen and Chunilal Bose. Tara Prasanna Roy took his classes in Inorganic Chemistry for a long time and also started his special classes in Applied Chemistry. These classes helped students to find employment. The famous Geologist Pramatha Nath Bose lectured on Geology for some time but due to heavy engagements in office could not spare much time for these classes. Biology was begun in 1894 and Mahendralal himself inaugurated it. Later Dr. Nilratan Sircar and Banwarilal Chowdhury took over. Girish Chandra Bose started Botany. Students from various colleges used to attend these classes. In the report of 1887, it was estimated that over three hundred students attended these lectures. Rev. Lafont in a lecture in 1881 explained the real purpose of this series on popular science. It was not to enable students to pass their examinations but to inform all about the progress of modern science and bring science within the reach of common people. Mahendralal Sircar reported in 1901 at the Twenty-forth Annual General Meeting that almost a hundred such lectures used to be arranged each year. Members and their nominees could attend these lectures without any fees and the public and the students could also do that on payment of a nominal fee.[14]

Dawn magazine, Dawn Society, Mahendralal and Popular Science

From 1901 till his death in 1904, Mahendralal in more than one lecture bewailed the fact that because of the lack of charitable disposition of his countrymen, neither higher research nor popular science could be effectively undertaken at the IACS. It virtually became a private college for the pursuit of science. To fill this gap, Satish Chandra Mukherjee launched his campaign for the spread of science in the *Dawn Magazine* in 1897. His objectives were to retrieve the heritage of science of ancient India, assimilate Western science, spread science among the masses and encourage technical education for employment. The *Dawn Magazine* was dedicated to this fourfold objective. The great men of that time joined him in this campaign. More than fifty essays were carried by *The Dawn* on popular science and the writers included Prafulla Chandra Ray, Jagadis Chandra Bose, Ramendra Sundar Tribedi, Nilratan Sircar and Sarat Dutta. Dr. Mahendralal Sircar also got involved with *The Dawn,* when the Dawn Society was established in 1902. Lectures on popular science and training in technology went on apace under its aegis. Among the essays on popular science published in the *Dawn Magazine,* the following may be specially mentioned : 'The Material Triumph of Science : Report from The Scientific American', (May, 1897), 'Charles Darwin's Mother Nature' reprint from the Progressive Thinker (December, 1897 and January, February 1898), 'Mind in All Animal Life' (March, 1898), 'Fire Proof Tree' (April, 1889), 'Organic Life and Matter' (September, 1898), 'Molecules, What They Are and How They Behave' (April-June, 1901), 'Liquid Air and Solid Air' (September, 1901), 'The Secret of Long Life' (1901), 'Is Matter Alive: Some of the Latest Researches of J. C. Bose' (November, 1902), 'The New Alchemy' (February, 1904).[15] Three essays by Mahendralal Sircar can be traced in this magazine. These are : (1) 'Educational Value of the Physical Sciences from a Moral Point of View' (September-December, 1901). (2) 'Can Physical Science Enlighten Man as to His Destiny' (1901). (3) 'Wireless Telegraphy : As illustrative of the Progress of Science and its Applications' (July-August, December, 1902). As these were not known to historians of science so far, some specimens are given below:

The first is from 'Educational Value of the Physical Sciences from a Moral Point of View' : "It may be questioned in the very beginning if the Physical Sciences can have any possible value in relation to the moral conduct of persons who are engaged in their study ... ... a physical science embraces a vast or rather limitable field. This is no other than the whole material universe. But infinite as the field may be the study of it is capable of simplification, and has been simplified. And this simplicity as we shall see is of deep significance. The study of the object under his immediate control in the tiny world we inhabit has enabled man to extend his study of the worlds... to the immensity of space and he finds to his utter amazement that all these worlds own a most intimate kinship with each other."[16]

The following is from "Can physical science enlighten man as to his destiny?":

Propagation
A Journal of Science Communication

"The study of physical sciences has opened out to man a vista, wider for both in point of space and of time than that bounded his earthly existence and has thus compelled him to take a larger view of his destiny... It is only by a systematic study of the physical universe which is cognisable by physical sense that he finds the universe a cosmos, a well ordered harmonious whole with the impress of a directing intelligence... the contemplation of the Universe under the guidance of scientific study brings the human mind in contact with a Mind which is like itself but infinitely transcending in all its attributes."[17]

The next excerpt is quoted from Wireless Telegraphy : "The reason, why wireless telegraphy is being made so much of, and it is looked upon as a marvel in these days of scientific marvels is that whereas in ordinary telegraphy messages are conveyed by a continuous wire conducting an actual voltaic current from one station to another, this continuous connecting wire between two stations is absolutely dispensed with in this form of telegraphy. The messages are conveyed across space not by what is called an electric current but by some influence which is electrical in origin."[18]

This account of the life-long labours of Dr. Mahendralal Sircar for the promotion of popular science should end all controversies during his life time over his scientific pursuits having an aristocratic bias. He wanted to train the first generation of scientists for nation-building purpose. It was very difficult in colonial India to become independent scientists. Mahendralal wanted to make it possible. The first generation would train the next generation and in this way India would be having scientists. In a land of handicrafts, common artisans were always available but to improve their skill and standard of production, trainer scientists were needed. For the improvement of theoretical and practical science, Mahendralal wanted to make his institution, the IACS the bedrock. His contemporaries opposed him in the name of popular science without trying to comprehend his purpose, but Rajendralal Mitra and Rev. Lafont understood him and supported him. His dream would be fulfilled. Otherwise Indian artisans and mechanics would for ever be under the tutelage of foreign supervisors, which would be expensive, dependent and uncertain. The IACS succeeded in producing the first generation of scientists. Swadeshi industry rose from the level of carpenters, blacksmiths, weavers and dyers. The IACS spawned the scientists. The Dawn Society and the National Council of Education played their complementary parts and produced the technologists. Besides, the IACS used to arrange at least a hundred lectures each year with and attendance of over three hundred people. This was enough to scientist a generation. Mahendralal himself gave such lectures on popular science for a long period and even towards the end of his life, he continued to write essays on popular science in the *Dawn Magazine.* His work was for the benefit of the people and the country as a whole charged by his intense patriotism and nation-building zeal. He was also the pioneer of popular science.

National Council of Education

In the third phase another Institution took prominent part in popularization of science. It was the National Council of Education founded in 1906. In the formative years it had two bodies, Bengal Technical Institute and the Bengal National College which was devoted to the teaching of the basic Arts and Science. In their separate ways, they contributed much to create a scientific community. The Bengal Technical Institute was renamed College of Engineering and Technology from 1928. This was the breeding ground of exceptional scientific minds. Some of the original papers of the student of CET which appeared in its journal show the depth to which popularization of science had gave in colonial Bengal.

It has already been pointed out in a previous chapter describing the debate over the foundation of the Indian Association for the Cultivation of Science that Rajendralal Mitra despaired of the success of the technical institutes in creating a base of technology for the country. They succeeded only in honing up the native skill of artisans. This was the fate of his own Mechanics Institute. Theoretical Science was thought to be the need of day and citizens of Calcutta voted for Mahendralal Sircar's Indian Association for the Cultivation of Science in preference to the proposed Albert Technical Institute in 1876. Since then the IACS continued to create pool of scientists for national reconstruction. But the IACS did not have programme for technology. This was taken up by the Dawn Society in 1902. Though it had both theoretical and practical courses for technology, it was just a small beginning. It lacked qualified teachers and adequate facilities of a workshop. The Dawn Society soon got merged into the National Council of Education in 1906 in the tumultuous days of Partition and its aftermath. The NCE set up a parallel system of national education in contrast with the Calcutta University imparting colonial education. One of its wings, the Society for the Promotion of Technical Education (SPTE) set up the Bengal Technical Institute which ran separately from the Bengal National College strictly on vocational basis without the surrogate of national education. The BTI became a successful institution attracting talented teachers and students alike. In 1928, it was transformed into the College of Engineering and Technology (CET). Its history has already been told in the previous chapter. In this essay, it will demonstrate how the CET acted as the catalyst of the transition from technique to technology.[19]

Salmon, in his essay on the advent of technology, has rightly remarked: technology is nothing but technique plus theory. The students of the CET had the fortune to study under illustrious Swadeshi Technologists like F. N. Bose, Sarat Kumar Dutta, Hem Chandra Dasgupta, Hiralal Roy, Baneswar Das, Bhim Chandra Chatterjee, Hem Chandra Guha among others. Their training in both theory and practice of diverse aspects of engineering made them both theoretically sound and practically useful.

A brief resume of their original and substantive writings of various aspects of technology is attempted now with reference to some of their papers published in the journal of CET between 1934 and 1947. The first citation is from 'Wireless Telephony' published in 1934 and written by Sudhanshu Shekar Sinha, a fourth year student of Electrical Engineering. The introduction is quoted below:

Wireless telephony is not so new and almost unborn as is generally supposed to be like its companion art, wireless telegraphy; it began its existence well back in the nineteenth century. Its inception is contemporaneous with that of wire telephone, for Alexander Graham Bell was the originator of both. It is a singular coincidence that Bell, the inventor of the telephone and Morse, the reputed inventor of the telegraph, should each have been among the first to accomplish their respective modes of communication wirelessly. The history of wireless telephony follows very closely that of wireless telegraphy. The extreme sensitiveness of the telephone receiver to small variation of current very naturally suggested its employment as a receiving device in connection with the induction and conductive methods of wireless telegraphy and attempts were made at an early date to accomplish the transmission of articulate speech by these same means. The results obtained however were very meagre; the inherent difficulties characterizing these methods proved to be even greater with the application of telephone principles due to the diminution of energy made necessary by the nature of the process. As in the case of wireless telegraphy, the root of the problem lay in the application of the methods electric radiation.[20]

Sinha then goes on to summarise the experiments so far made of telephony by means of Hertzian-waves tries to access the state-of the-art in telephony by giving his own observation.

In the case of an oscillation generating arrangement which does not produce a perfectly sustained train of electric waves but a series of partially damped wave-trains separated by slight breaks of continuity, the essential condition for success in connection with radiotelephonic work is that the interruption shall not take place at an audible frequency. It is highly probable that the direct-current are method of creating oscillations does not produce an absolutely continuous train of waves, as in the case with a high-frequency alternator but on the contrary, is made up of a great number of groups of almost undamped Oscillations separated by an interval of time, very small even in comparison with the duration of each group.[21]

This theoretical exercise by Sinha is remarkable for a fourth year engineering student. It not only speaks of his command over the subject but his ingenuity at the end. These are the soundings of technology in a country of no such tradition.

The same Sinha wrote another essay in the same year on an emerging area even of today. This was entitled, 'Oil from Coal'. Here is the preamble:

Because of the rapid process of mechanisation of the army and of civilization in general, liquid fuel has become of utmost importance in the present state of inevitable quick march of event. Oil-sources are located at considerable distances from seats of power of different nation, some of which are without any oil-field within their own country, colony, protectorates or mandated area. In peace-time, one can buy oil from other countries but during war, possibility of such purchases becomes a doubtful proposition. So semi-industrial plants for the production of liquid fuel must be kept in running condition to be utilized in case of national emergency. Col. K. C. Appleyard, at a meeting of the Midland Section of the Coke Oven Managers's Association, showed by facts and figures that there is no possibility of these processes for the production of liquid fuel from coal or its gaseous products, yet becoming economic in the true sense of the word ....

There are two processes in trial operations by subsidization for the synthetic manufacture of liquid fuel from coal by treating it with hydrogen under pressure at suitable temperature in the presence of suitable catalyzers and activators. The later obtains the oil from sulphur-free water.

The development of these processes had been possible by the pioneering work of hydrogenation by Sabatier and Senderens and high-pressure technique achieved by Haber and Bosch.[22]

Sinha then goes on to survey the aforesaid theory in detail and make a critique of the Fischer - Tropsch process :

Attention has already been drawn to the fact that the Fisher - Tropsch reaction is exothermic, and one of the problems has been the dissipation of the heat generated by the reaction. Many types of reaction chambers have been tested before the final design was adopted and in the apparatus finally agreed upon, the catalyst is arranged between hollow space through which a steam of water flows which can be regulated to maintain constant temperatures.

The fraction boiling over about 210°C provides an excellent Diesel oil when the dissolved paraffin has been removed. It is found to have excellent combustion properties and gives a clear exhaust even with a considerable overload on the engine, while its high hydrogen content enables it to be used with a better fuel consumption than petroleum Diesel oil. Lubricating oil can be manufactured by a by-product of the Fischer - Tropsch process, by polymerising the fractions containing olefixes with anhydrous aluminium chloride. Alternatively, high boiling tractions, low in olefixes can be chlorinated to produce mono or dichloro-derivative, these oils being subsequently caused to polymerise and simultaneously being dechlorinated by finely divided metallic aluminium. It has now become possible to produce lubricating oils possessing the most varying properties. They are adjustable to such an extent that lubrication oils suitable for any purpose whatsoever can be produced synthetically.[23]

Sinha once again shows his grip over a post-modern subject of science and has the originality of approach to this subject of the 21st century.

Mention can also be made of another interesting article entitled 'Fuel Injection System' by Jnan Kumar Mukherjee, a final year student of Mechanical Engineering. The following are excerpts from his learned article ...

During past sixteen years the development of automotive Diesel and Oil Engine is progressing considerably. The success of this development has been due greatly to the co-operation of the engine designer, the metallurgist, the production engineer and the petroleum technologist. In its general construction Diesel Engine is almost identical with the Petrol Engine except the combustion system. In Oil Engine, there are two principal combustion systems :

1. Air injection or blast injection.
2. Solic injection (mechanical injection, airless injection or pump injection)

..... Difficulty arises regarding the amount of fuel to be injected during each complete cycle. For example, an engine developing 25 H.P. per cylinder at 1200 r.p.m., the amount of fuel injected .007 cubic inch. This amount of fuel during injection must be filtered well ... In case of Diesel and Oil Engine which operate over large range of speeds, it is essential to vary the point at which the injection of the fuel begins in order to compensate for the ignition lag. Means are provided to allow the point of injection to be controlled, either manually or automatically. The mechanism is usually incorporated in the injection pump housing. Many engineers are provided with a vernier coupling on the injection pump drive shaft to allow a permanent alternation of the point of injection.

In order to obtain easy starting of the cool cylinders, glow plugs like spark plugs are used to heat the mixture. Instead of two electrodes it has resistance wire filament which becomes red hot when the current passes through it.

These are the general equipment of the injection system of the Oil Engine. Every part of this system should be in perfect state so that perfect combustion and consequently the output of the engine will be ensured.[24]

The author was not only aware of the new type of injection system used in the general motor companies; he was trying to suggest improvement on the system in his own original thinking. He was surely capable of manufacturing operational Diesel and Oil Engines.

We come across a scintillating paper on 'Television' by Satyabrata Majumdar, a third year student of Mechanical Engineering. He proceeds lucidly to explain the inner mechanism of television in this way:

The most amazing wonder of the present times which augurs to go a long way toward the welfare of man is the recent invention of the phenomenon of television. Most of us have had the direct experience of working a radio or getting a radio receiver cater songs, orchestra, speeches etc. to our satisfaction. The performances occur at a spot far away from the radio receiver the function of which is just to catch those things from the air and serve us the same. Likewise, television helps us to see before our eyes speakers, actors etc. making their respective performance which they do at a great distance. It fell to the lot of,-English Scientist named 'Baird' to be the inventor of this wonderful phenomenon in 1925. Let us see how we can position to understand the working of television. if we divide a picture into very small imaginary parts and if a strong ray of light is made to travel through all the parts within a very short time in a dark room what we really see? We see a glimpse of the whole picture as long as the ray of light continues travelling. This contiguity of vision in spite of breaks however short of the successive lighting of the imaginary parts of the picture has been called the 'persistence of vision'. Our eyes continue seeing a thing in front of it for a very short time after it is withdrawn from our view. So, when the ray of light travels through the picture quickly, our eye can see the whole picture. The imaginary parts of the picture are lighted successively by a ray of light. The process is called "Scanning" and the machine used for this is "the Scanner". This constitutes the most necessary element of television.[25]

He concludes :

Nowadays, war pictures are sent through radio in the same way as stated above. This is called "Radio Photo". It has been found possible in recent times to transport a wholly complete newspaper by means of television. May we draw from it that in a not very distant future that world will be able to read an international newspaper which will carry the message of love, unity and facilitate to a greater extent with more development in the technique of 'Television'.

Though Majumdar knew the technology of television, it took more than 50 years for India to launch her own television system due to infrastructural difficulties and political disturbances. But when the time came television sets became a household product is a trice, as the knowledge was on the fingertips of Indian engineers gathered from the early days of CET.[26]

We now turn to our last quote from a paper on 'The Structure of the Atom' by S. Bhattacharyya, a third year student of Chemical Engineering published in 1937 :

Ever since the discovery of the election m 1895 and of the recognition of the fact that it formed universal constituent of all matters, the older ideas regarding the atom as an ultimate constituent of matter which was not further divisible, became unfamable. Now, as the atom contains negatively charged electrons and because the atom is electrically neutral, it must contain positively electricity in some form or other. But what was the nature of the positive electricity which neutralized the negativity, remained for a time a vague surmise physicists began to speculate about the way in which the atom of positive and negative electricity were combined to form the different kinds of atoms. The first suggestion came from the famous Physicist Lord Kelvin and was further elaborated by Sir, J.J.Thompson. They held that the positive electricity was concentrated in a sphere of about the same dimensions as the atom and the electrons were uniformly distributed throughout the sphere.

But the true nature of positive electricity was investigated by the bombardment with high speed positively charged particles (α particles) by Rutherford and his students.

C.R.T. Wilson developed a method by which the paths of these particles might be rendered visible and even photographed; if those particles are made to pass through super saturated water vapour the supersaturation of the vapour is destroyed by them, the molecules of the gas which are encountered by the traversing a particles become ionised and these gaseous ions form the centres of condensation of water from supersaturated aqueous vapour actually becomes visible, when suitably illuminated, as a fine line of mist. It is observed that most of the particles travel in straight lines, which could not be the case if they were deflected from their course by impact with every atom they encountered a few are diverted to some extent and very frequently complete reversal of direction of motion occurs.[27]

This was the height of theoretical exercise by an engineering undergraduate. Artisanal technique had been elevated to a high level of technology. Benoy Sarkar was not far from truth when he asserted that the Jadavpur boys had become avant gardes of industrialisation and modernisation of India. They had successfully assimilated Western technology and enriched it by their own ingenuity.[28]

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