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AN OUTLINE SURVEY OF SOME ASPECTS OF TECHNOLOGY IN INDIA, 1750-1900 AND ITS LEGACY

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1. INTRODUCTION

1.1 Poverty of the masses had been and is the key problem of India and other developing countries. The level of living to a great extent is a function of technology. A higher technology or improved method of production implies a higher productivity and thereby a higher aggregate production. Any scientific advancement leads to a technological progress on the one hand and a higher level of rationalism in society on the other.

1.2 Dr. Claud Alvares in his highly controversial book on technology and culture points out to the recognised fact that India, China, and even Africa had a technological past and certainly a better one than the West until 1800.[1] The past achievements of Indian science and technology are well-known in branches like mathematics, astronomy, botany and medicine, in several branches of technology including a high skill in metallurgy. Since the mediaeval period, there is a marked stagnation and decay, but Indian textile fabric along with some other wares seems to have hold the fort successfully as indicated in the table below.

TABLE 1

***Share of Bullion in Total Exports by the English East India Company to Bengal*[2]**

years	percentage of bullion
1	2
1721-30	83
1731-40	66
1741-50	75
1751-56	67
1757-65	nil

1.3 So much influx of bullion was a normal feature of the Indian trade up to the Plassey. It implies that at the given level of living, India was either self-sufficient in essential consumer goods or the U.K. had no wares to offer in exchange.

1.4 It may be mentioned that during the Mughal and Mahratta days "a list called Khanasumari containing a statement of number of the houses, families, tradesmen, carts, ploughs, looms, tanks and other public works, civil and religious is kept under all native governments." The Britishers conducted statistical surveys in the early period following Khanasumari records. Considerable information about the level of technology in each village was furnished in these tables by way of an enumeration of instruments of production.[3] A developed system of cadastral survey also seems to have prevailed in India.

II. 1750-1800

2.1 In the history of mankind, the period 1750-1800 represents a combination of events having far reaching consequences such as the battle of Plassey (1757), the Industrial Revolution (1760-), the American war of independence (1776), publication of Adam Smith's *Wealth of Nations* (1776), and the French revolution (1789). In England, there were at least 25 technological innovations initiating the process of industrial revolution that makes, according to Maurice Dobb, a watershed in human history.[4] The *Wealth of Nations* served as a light house of political economy for many years to come.

2.2 The British conquest at Plassey was followed by the acquisition of the *Dewani* of the Provinces of Bengal by the East India Company in 1765. New acquisitions continued to increase. A glance over the magnificent volumes of the *Historical Records of the Survey of India*[5] will reveal that every piece of conquest was followed immediately by a large number of surveyors and other investigators to have an accurate grasp on the geography and natural resources of the conquered territory. The East India Company, though condemned by Adam Smith to represent the worst form of Government, was able to throw a brilliant set of inquisitive scholars and individuals in exploration of the new territories—their plains and hills, lakes and rivers, flora and fauna, minerals and manufacturers.

2.3 Among the achievements up to 1800, special mention may be made of a successful completion of Rennell's *Bengal Atlas* based on scientific principles, introduction of topographical, astronomical and military route survey in the acquisitions with a sweeping speed, foundation of Asiatic Society in 1784, that of the Royal Botanical Garden or the Company Bag at Shibpur in 1786. Erection of an observatory in 1793 and foundation of a Survey School in the following year at Madras by Michael Topping were two feats in the technological field.

2.4 As early as 1757, Lord Clive wrote to the Council at Fort William as recorded on the 1st August, 1757 informing the beginning of a survey of the lands, villages,

districts, revenues, etc., to start from the Great Lake (perhaps the Salt Lake). Berthalmew Plaisted started a coastal survey from Chittagong, Hugh Cameron became the surveyor of new lands of 24-Parganas. He was succeeded by James Rennell after his death in 1764. In early 1767, Rennell became the Surveyor General. In 1774, he submitted to the Government a complete set of provincial maps (1″=5 miles). In a considerable short period of 12 years, Rennell produced a uniform set of maps of the territories of Bengal and Bihar with as accuracy as possible under given circumstances.

2.5 In South India, Colonel Upton's survey of route to Poona in 1775 and John Coll's survey of military routes in Trichinopoly, Tinnivelly and Madura, Henry Montresor's compilation of a general map of the southern peninsula, the survey of Chingleput Jagir by Barnard and the survey of the Northern Circars although not completed are worthy of a notice as early attempts. Discrepancies began to appear in geographical positions suggested by the surveys and therefore, Reuben Burrow, an eminent mathematician, was called upon for a special astronomical survey. The Andaman islands were also covered by a number of able officers like Alexander Kyd, Archibald Blair and Robert Colebrooke. Surveys of the west coast were also carried out. The interest of the Company also extended to Assam. Captain Welsh was deputed in 1792. His letters to Lord Cornwallis and to Sir John Shore contained a mass of information about this little known country.

2.6 The Mysore Survey is a good illustration of the quest as well as motive for scientific information of the East India Company's administration. Seringapatam was captured on the 4th May, 1799 when a preliminary work of compiling maps was done immediately. The Governor General appointed Colin Mackenzie to undertake "a survey on extensive scale of the territories lately subjected to the company." According to the *Plan of the Mysore Survey* submitted by Mackenzie on the 5th January 1800, it should embrace two great leading objects, *mathematical* and *physical*. The mathematical part including a geographical and geometrical survey would comprehend the frontier and exterior boundary of Mysore, involving a series of primary stations to be obtained forming a series of triangles connected by bases to be carefully measured. The physical branch comprises everything conductive to the improvement of natural history including (*a*) botany, minerology and medicine, (*b*) the diseases, medicines, remedies, (*c*) the air, climate, seasons, periodical rains, (*d*) soil, its produce, modes of cultivation, waterworks, tenures of land, (*e*) the various classes of natives, their customs, languages, manners, (*f*) animals, wild and domestic, (*g*) revenue and population. Dr. Benjamin Heyne, a botanist attached to Madras Medical Services, was deputed to assist Mackenzie.[6]

III. 1801-1850

3.1 By the end of 1803-6, the Company's territory expanded further to include the whole of Orissa, a considerable part of Bundlekund, Salsette and Surat. In 1808-

10, scare of Napoleon's threat to invade India made the Government to send several political missions beyond the western frontiers accompanying surveyors moving in Sind, Peshawar and Lahore. After the Nepal War, John Anthony Hodgson started regular survey in the newly gained Himalayan districts.

3.2 In the Southern India, the survey work continued under four streams—(*i*) district surveys under the professional charge of the Inspector of the Revenue Surveys or of the Superintendent of Tank Repairs controlled by the Board of Revenue, (*ii*) military institutions and military surveys under the Quarter Master General, (*iii*) Great Trigonometrical Survey under William Lambton and (*iv*) topographical surveys under Colin Mackenzie.

3.3 We should spell out something about the achievement of the Asiatic Society of Bengal as an unofficial agency of the exploration of intellectual and material resources of India. A large number of officials who conducted field surveys or observations or experiments in different branches of science and technology contributed to its journals.[7] As early as 1799 there was a contribution on petroleum wells in Burma. Articles on topics like sources of Ganges or the height of the Himalayan mountains or mineral resources in several parts of the country were published regularly. It may be pointed out that during the first fifty years, there were about 500 papers in mathematical and physical sciences, zoology, geology and botany.

3.4 Dr. Francis Buchanan travelled over a year in Mysore and adjacent areas in 1800 to survey the newly acquired territories making valuable collection of botanical and geographical materials. He served as the Superintendent of the Botanical Gardens at Sibpur for a few months. He was entrusted with the responsibility of conducting a statistical survey of the country under the immediate authority of Fort William to cover the topography, history, climate, people and their number, clothing, religion, education, custom and manners, natural productions including animal, vegetables and minerals, mode of tillage, implements of husbandry, breeds of cattle and safeguards against floods, and many other things. Accounts of the seven districts under Fort William were submitted to the Government containing 10,000 folio pages of manuscripts. The survey enumerates resources, the extent of their utilization and also indicates future potentials.[8] According to P.C. Mahalanobis, nothing like this occurred in India in the next 140 years.

3.5 One of the most important scientific and technological achievements of the administration in the nineteenth century was the introduction of Trigonometrical Survey. In 1799 William Lambton put forward his first proposal for a mathematical and geographical survey. Between 1802-15, Lambton covered the entire peninsula, south of the Krishna "with a net work of triangles, braced by main cross belts. He had fixed the geographical position of several thousand prominent points, and had compiled a general map of the southern peninsula, south of Mysore. He had observed arc of the Meridian stretching from Cape Comorain to parallel 18°, the longest geo-

detic arc ever measured so close to the equator....."[9]. He computed results and published them forming a contribution to the subject. An overworked Lambton died at the age of 70 in 1823.

3.6 Prior to joining as Surveyor General in India and Superintendent of the Great Trigonometrical Survey in 1830, George Everest published the results of his observations between 1823 and 1825 under the title "*An Account of the Measurement of an Arc of the Meridian between the parallels of 20°3′ and 24°7′*" in England. While in England he convinced the Court of Directors about the priority to extend the great Meridional arc to the Himalayan mountains. He also procured sophisticated instruments and engaged Henry Barrow, a skilled instrument maker, for repair and reconstructions of those instruments. In Bombay, in Bengal, in Central India and Rajasthan, in Assam, in the Sunderbans and in the Upper Provinces topographical surveys also continued. By 1841, Everest's field work of the great arc from 17°55′ to 30°29′ was completed along with three subordinate meridional series—three others being on progress. Everest built up a great organisation suitable to difficult conditions, traversed the flats of the Ganges Valley, as well as the ranges of the Himalayas and trained a team of able officers before he left at the end of 1843 handing over to his colleague Andrew Waugh.

3.7 Two Indians of recognised ability and contribution deserve special mention—Sayed Mir Mohsin Hussain and Radhanath Sikdar. Everest recognised talents and services of the former in carrying into effect his various projects for the remodelment of the instruments and appointed him as a mathematical instrument maker in place of Barrow in 1839. Radhanath Sikdar, acclaimed by Everest as one of high ranking mathematicians, was appointed as a computer along with six other scholars of Hindu College. He made his mark from the beginning and proved useful on approximation series across Jamuna Valley. In 1843, Radhanath moved to Calcutta to contribute to the preparation of Auxiliary Table. Another Indian, Mohan Lal Munshi, author of *Journal of a Tour Through the Punjab, Afghanisthan, Turkistan, Khorasan, and part of Persia in Company with Burns and Gerard (Calcutta, 1834)*, also underwent a regular course of instruction in surveying at Calcutta.

3.8 Andrew Waugh, who succeeded Everest, completed triangulation of the region between the Great Arc Series and Calcutta and thereafter also successfully completed the North Eastern Himalayan series. Of the heights of 79 Himalayan peaks determined, 15th peak at 29,002 ft. above the sea level was named by him as Mount Everest after the name of George Everest.

3.9 On the technology stream William Carey started the Agricultural Society of India which was renamed as Agricultural and Horticultural Society of India in 1826. The Bombay Natural History Society was established in 1848. The Calcutta Medical College was established in 1835 and a Medical School was established in

Madras in 1843 and another school in Bombay in 1845. An Engineering Institution at Roorkee was established in 1847.

IV. 1851-1900

4.1 In 1851 the Geological Survey of India formally came into existence with Thomas Oldham, F.R.S. as the Superintendent at the age of the thirty-five. The first telegraph line between Calcutta and Diamond Harbour opened in the same year. In 1853 the first railway line opened near Bombay and in the same year an Engineering School was established at Poona followed by the Engineering College at Sibpur in 1856. Three universities at Calcutta, Bombay and Madras were established in 1857. The Archaeological Survey of India came into being in 1859. The Indian Museum based on the collection of the Asiatic Society was established in 1867.

4.2 Geological investigations were conducted since late eighteenth century, but a systematic effort was made in 1836 when a committee to explore coal and other mineral resources of the country was formed. D. H. William of the British Geological Survey came in India in 1846 and serious efforts in exploration of coal resources in Eastern India started in a systematic manner to be expanded to other resources and other areas. Two Indians, P. N. Bose and P. N. Dutta, made worthwhile contributions in 1880's. In addition to the publications of the Geological Survey of India, a glance over the large number of *Selections from the Records* of the Government of India and Provincial governments will show how seriously the Britishers pushed the geological expedition.

4.3 Another important field is meteorology. It had an added political importance as the Indian revenue was a gambling of monsoon. The administration of the temporary and ryotwary settled areas used to make continuous report on rainfall and crop forecast since the early nineteenth century. Though the Indian Meteorological Department was established as late as 1875, investigations in the field started in the preceding century. In 1878, the system of daily weather reports in all parts of India was introduced. In 1895, the Solar Physics Laboratory was established.

4.4 In the field of industry, indigenous units with traditional techniques generally continued to decline, in some areas like cotton textile as a result of strangulation by fiscal measures imposed on political considerations. Jute mills in Calcutta flourished with British capital, and cotton mills in Bombay mainly with Indian capital. There was a rise and fall in the fortune of iron works at Barakar and Ranigunj leading to the formation of the Bengal Iron Company producing about 40,000 tons of iron by 1900.

4.5 The railways in India was a product of a combination of factors such as a shrinking market for British steel in the continent and in the United States, the necessity

of mobility of Indian raw materials and British finished products between ports and the interior, as well as mobility of army. With a small beginning of 20 miles in 1853, railway lines extended to 734 miles in 1860, to 4,832 miles in 1870, to 9,308 miles in 1880, 16,977 in 1890 and finally to 24,752 miles in 1900. In spite of this phenomenal growth, there were 0.016 miles of railway line per sq. mile.

4.6 More than 10,000 miles of telegraph lines were installed in 1860 making a beginning with 82 miles in 1852 to reach finally to 52,909 miles in 1900. There was also a considerable investment in irrigation covering nearly one-fifth of the cropped area in the British India. The growth of commercial crop, was another technological feat in the second half of the nineteenth century. From 1819, the irrigation works gradually expanded to conceive and implement large projects and as a result about 12 million acres were irrigated from canals in the British provinces by the end of the century.

4.7 Gazetteers on India right from the *East India Gazetteer* by Walter Hamilton in 1815 down to the volumes of Edward Thornton published in 1850's contained a massive volume of information compiled from existing records. In 1868, W. W. Hunter was appointed as the Director of the Statistical Survey for compilation of Imperial Gazetteers. Investigation in each district was conducted to obtain new data and existing information was also consolidated to form the series of Imperial and Provincial Gazetteers that began appearance in 1880's. The heads of information covered a large number of items bearing on technology such as meteorology, soil, climate, geology, flora, fauna, topography, agriculture, manufactures, etc.

V. Concluding Remarks

5.1 In 1922 Professor Meghnad Saha pointed out to the motives of the alien rulers in introducing western science and technology in India. By the time the Britishers were firmly established in this country, they had mastered the power with the help of coal and iron. They were far from self-sufficient with their own production. It was not possible for them to maintain an existence without appropriating from other countries. Their first task was to cultivate "fallow land" in India. India was rich in mineral and agricultural resources with an enormous volume of commerce. If we looked upon activities of the Chambers of Commerce, Geographical Survey, Trigonometric Survey. Agricultural and Botanical Survey, Mining Federation and Planters' Association, we should be able to understand what they did to get possession of these resources. Professor Saha further mentioned how the officials of the survey explored coal, gold, oil, iron and how the same set of persons after retirement became advisers to British capitalists leading to establishment of big Commercial Houses in India.[10]

5.2 Apparently, the East India Company was not interested in the territorial acquisitions in early days, though the Empire actually dated from 1765. The East

India Company, nevertheless, was able to get the blessings of the British Parliament who passed two enactments in 1772 and 1784 to regulate the territorial possessions in India through the East India Company. As Edmund Burke pointed out, the British Government came forward to have a share in the plunder.[11] Admittedly, there was a conflict between monopolists and free traders or between the commercial interest and rising industrial capital, but all seemed to be in complete agreement regarding administering the new possession to the best interest of the British ruling classes. Adam Smith and Malthus, Ricardo and James Mill, Jeremy Bentham and John Stuart Mill were in essential unanimity.[12]

5.3 Every step taken by the Britishers in exploring the resources of India through one of the ablest and largest survey organisation ever formed in the world had a single object. It has been noted earlier that surveyors accompanied or followed the army immediately after conquest of any piece of territory. A geographical, topographical revenue-cum-cadastral enquiry started as quickly as possible. In the eighteenth century, the Company wanted to maximize revenue for a larger and larger investment (the portion of revenue set apart for purchase of goods in India to be sold at London without any return to India). Exploration of natural resources started almost instantaneously after the conquest and continued on an ever increasing scale. The British steel industry was in need of a new outlet as American and continental markets were closed and this is one of the reasons of the introduction of railways in India. The technology at 1900 made little impact on the economy as a whole towards a self-generating process.

5.4 A mechanised Lancashire was seemingly unable to compete with Indian hand-woven manufactures and the history of British export of cotton fabrics is a history of prohibitive duties by the free traders who were out to destroy Company's monopoly. As Romesh Dutt summarised quoting from Friedrich List, "while British Political Economists professed the principle of free trade from the latter end of the eighteenth century, the British National declined to adopt them till they had crushed the Manufacturing Power of India, and reared their own Manufacturing Power[13]." They invested in plantation industries entirely to their benefit. Cultivation of cotton followed by a collaborative mechanised cotton industry was initiated only after American Civil War. Jute Mills in Bengal were established as a channel of profitable investment without any damage to England, thanks to the law of comparative cost. An extension of irrigation resulted in a prevention of famine with a better crop and thereby a better revenue. At the end of the nineteenth century, a scene of stagnation and decay looms large with more people falling back on agriculture, with a declining share of manufactures in the trade as well as in the aggregate production, with a very few Indians entering into the stream of technology in spite of a growing educated middle class arising from the stream of Western education.

5.5 The inherent contradiction in an imperialist order manifested in the growth of an intellectual middle class who conceived India as a nation and who aspired for

the economic development of India. The railways, and allied technology and the Western education initiated the process of a new era of thinking about the future of India. The Indian Association for the Cultivation of Science under the leadership of Mahendralal Sarkar was established in 1876. An association for the study of social sciences was also established. Indian intellectuals, Indian politicians and Indian journals began to think in terms of development though in a rudimentary form. Raja Rammohun Roy, Iswarchandra Vidyasagar, Akshay Kumar Dutta, Bhudev Mukhopadhyay in Bengal were in favour of a rationalism in society and modernisation in production. From this stream emerged Ashutosh Mukherji as a scholar in Mathematics, J. C. Bose in Physics and P. C. Roy in Chemistry. Actually India gained mainly as a result of inherent contradiction in the imperialist exploitation.

5.6 After about two centuries of *Wealth of Nations*, Gunnar Myrdal enquired into the poverty of nations[14]. There is a complete unanimity on the fact that in course of these 200 years, rich nations became richer, and poor nations poorer. Today over 50 per cent of the total research and development expenditure in the world is concentrated on defence. 90 per cent of total expenditure is again concentrated in eight industrialised countries. In spite of a phenomenal rise in the gross national product to the extent of 840 per cent since 1947, India is ranked among the poorer nations who are getting poorer in relation to the richer every decade and who are dependent on imported technology. Through technology the developing countries are also being dominated by the developed. Essentially, imperialism exists without Empire through the stream of transfer of technology revealing a thematic unity in pre-1900 India and post-independent India in relation to alien domination.[15]

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