Extra-Imperial Influences in Indian Industrialisation: The technical experts of the Tata steel works, c. 1900-40[*]

APARAJITH RAMNATH[+]

Introduction

In the interwar period Indian business families (such as the Tatas, Birlas, Walchands and Kirloskars) began to invest heavily in large-scale industry, challenging European-owned firms for the first time.[1] One of the more prominent of these ventures was the Tata Iron and Steel Company (TISCO). TISCO was the first major producer of steel in India; it achieved a near-monopoly in the domestic market; and its success was instrumental in the creation and operation of several ancillary industries that consumed steel.

Economic historians have argued that TISCO was an exceptionally successful case among large-scale industrial enterprises in interwar India in that it overcame many of the constraints on industrialisation under the colonial government, including inadequate protection of Indian industry, insufficient domestic demand, lack of technological know-how, and scarcity of capital.[2] TISCO's success

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[+] Visiting Assistant Professor, Humanities and Liberal Arts in Management, Indian Institute of Management, Kozhikode (Kerala).

[1] Dietmar Rothermund, *An Economic History of India: From Pre-Colonial Times to 1991* (2nd edition, London: Routledge, 1993), p. 92; Rajat K. Ray, *Industrialization in India: Growth and Conflict in the Private Corporate Sector 1914-47* (New Delhi: Oxford University Press, 1982 [1979]), p. 5; B.R.Tomlinson, *The Economy of Modern India, 1860-1970* (Cambridge: Cambridge University Press, 1996 [1993]) (*The New Cambridge History of India*, III, 3), p. 143.

[2] Rothermund, *An Economic History of India*, pp. 61-5; Ray, *Industrialization in India*, pp. 3, 81, and Ch. 4; A.K. Bagchi's argument as described in Tirthankar Roy, *The Economic History of India 1857-1947*, second edition (New Delhi: Oxford University Press, 2006), p. 263. Although the literature emphasises the limits of industrial growth, it does show that there was an appreciable growth in large-scale industry over the interwar period (see Ramnath, 'Engineers in India', Chapter 2).

is attributed variously to the vision and foresight of the company's founders, the management's good relations with the colonial government and its resultant obtaining of economic protection, capital investments made after World War I, and effective sales strategies.[3] Yet the literature does not pay sufficient attention to another very important factor: TISCO's strategies in recruiting and training its engineering personnel. An exception is historian of technology Daniel Headrick's brief account of the creation of TISCO and the Indianisation of its technical personnel.[4] Whereas Headrick uses his account to illustrate his larger argument that 'technology transfer' in colonial India was of a limited nature,[5] this paper takes the industrial experts themselves—their backgrounds, skills and characteristics—as its primary subject.

Using published memoirs, company newsletters, and a range of primary materials in the Tata Steel Archives, this paper identifies and studies in detail several technical experts of TISCO in the interwar period. It shows that while the role of British engineers was significant, the technical work of TISCO was not led or directed by British expertise (unlike in the case of the Indian public works and railways).[6] Instead, Americans and American-trained Indians were the most important of the multi-national group of experts that ran the technical operations of this pre-eminent industrial enterprise. These superintendents and managers, many of whom were schooled in the steel works of their home countries, shaped a working culture that laid great store by practical experience, physical fitness and presence of mind on the shop floor.[7]

In the interwar period, economic considerations made it important to replace as many of the foreign experts as possible by Indians. This process of Indianisation was systematised through the Tatas' Jamshedpur Technical Institute (JTI, est. 1921), a pioneering step in industrial education in the country.[8] Focusing on the JTI's staff, curriculum, funding, selection of students, and the educational context in which it was established and operated, this paper argues that a level of continuity in the work culture was maintained while pursuing Indianisation. Indians trained in the Institute were expected to combine a mastery of the theory of steel manufacture with intensive practical learning in the TISCO works itself.

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[3] See Ray, *Industrialization in India*, pp. 74-93; Chikayoshi Nomura, 'Selling steel in the 1920s: TISCO in a period of transition', *Indian Economic and Social History Review*, 48, 1 (2011), pp. 83-116.

[4] Daniel Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940* (New York and Oxford: Oxford University Press, 1988), pp. 285-94 and pp. 371-4. Dwijendra Tripathi mentions in brief the role of TISCO's research and development facilities in developing new products, but this applies to the period from the late 1930s onwards. Dwijendra Tripathi, *The Oxford History of Indian Business* (New Delhi: Oxford University Press, 2004), pp. 228-9.

[5] See Headrick, *Tentacles of Progress*, p. 9 for his definition of technology transfer.

[6] Engineers in the Indian public works and railways are studied in Ramnath, 'Engineers in India', Chapters 4 and 5 respectively.

[7] While the existence of foreign experts is recognised in the existing literature, their training, the nature of their expertise, and the culture of engineering they brought to TISCO have not been studied before.

[8] Several accounts of TISCO mention the Institute and its role in Indianisation, but none explores at any length the Institute's functioning. E.g. Ray, *Industrialization in India*, p. 91; Headrick, *Tentacles of Progress*, p. 373; and Hiruyoki Oba and Hrushikesh Panda (eds.), *Industrial Development and Technology Absorption in the Indian Steel Industry: Study of TISCO with Reference to Yawata — A Steel Plant of Nippon Steel Corporation in Japan* (Mumbai: Allied Publishers, 2005), Chapter 6.

Physical fitness and industriousness remained important, being key parameters in the selection of students for the Institute and thereafter for jobs in the works.

Along with the strong American influence in the form of the first generation of managers and steel-makers, the JTI phase showed that the role of the colonial education system in TISCO's Indianisation was small. This stands in contrast to the government services, in which most Indian technical experts had been educated at the state's engineering colleges (which had the patronage of Public Works Department appointments) or trained at government-run railway workshops and technical schools.[9] Studying technical experts, then, gives us a glimpse of the transnational nature of large-scale industrial enterprise in interwar India: linkages in personnel, expertise and machinery went beyond the relationship between imperial metropolis and periphery.

Multi-national experts and the culture of steel-making

Although the Tata Iron and Steel Company was formally registered in 1907, the first steps towards its establishment had already been taken at the turn of the twentieth century by Jamsetji Nusserwanji Tata, a successful owner of textile mills in Bombay and Nagpur. According to his biographer, J.N. Tata had long nurtured the ambition of setting up an iron and steel works in India, where no producer of steel existed. By the end of the nineteenth century, preliminary reports had been published indicating iron and coal deposits in India, and in 1899 the government relaxed its restrictions on mining by private agencies. Tata then secured prospecting licences for some districts in central India and had his representatives explore the area for ore.[10]

From this stage through to the early years of the plant's functioning, the technical work of the company was carried out by an international group of experts under the direction of Americans. This expertise was embodied in several types of personnel: those who carried out the initial prospecting; the construction engineers who built the plant itself; the technical superintendents and managers who ran the various production departments; and the experts in charge of the rest of the plant and the township in which it was located.

The role of American construction engineers began soon after Tata had acquired his prospecting licenses. In the early 1900s, he travelled to the USA in search of expert assistance. In doing this he not only acknowledged the contemporary success of America's steel industry, but also took the then unusual step of venturing beyond the British Empire. While in America, Jamsetji 'studied coking processes at Birmingham, Alabama, visited the world's largest ore market at Cleveland, and in Pittsburgh met the foremost metallurgical consultant, Julian Kennedy.' Kennedy agreed to build a works in India provided a

[9] See Ramnath, 'Engineers in India', Chapters 4 and 5.

[10] R.M. Lala, *For the Love of India: The Life and Times of Jamsetji Tata* (New Delhi: Penguin/Portfolio, 2006 [2004]), Chapter 18. Although a company called the Bengal Iron Works was already functioning, it had so far manufactured only iron, not steel. Headrick, *Tentacles of Progress*, pp. 282-4.

detailed survey of materials was conducted. He recommended for the survey the New York consulting engineer C.P. Perin.[11]

The grandson of an engineer, Charles Page Perin (b. 1861) had an A.B. from Harvard College, and had also studied at the Écoles des Mines in Paris. Working his way up as an engineer in the Carnegie Steel Company and in steel plants in Alabama, Kentucky and Tennessee, Perin set up as a consulting engineer in 1900. He was credited with the building of coke plants, whole industrial towns in Virginia, and an electrolytic iron works at the Niagara Falls. In the course of his career he worked in various countries including China, Spain, South Africa and Russia.[12] It was in 1902 that Jamsetji met him upon Kennedy's suggestion. Perin accepted the role of chief consulting engineer to Tata's putative steel works (his firm continued to be consulting engineers to the Tatas' steel company until 1936).[13]

Over the next few years Perin's partner C.M. Weld successfully led explorations in North-Central India culminating in the selection of a site for the steel plant: the village of Sakchi, less than 200 miles west of Calcutta.[14] Although Jamsetji died in 1904,[15] the enterprise continued under his son Dorabji. In 1907 the Tata Iron and Steel Company was registered, a sum of Rs. 23.2 million having been raised from investors in India. Tata and Sons (later Tata Sons) of Bombay held a share of 11 per cent in the new company and were appointed TISCO's managing agents.[16]

The American engineers of Julian Kennedy's and Perin's firms led the building of the new plant at Sakchi (later renamed Jamshedpur after Jamsetji Tata). Axel Sahlin, from Julian Kennedy, Sahlin and Company, arrived in February 1908. He was accompanied by W.O. Renkin (c.1875-1943), who was appointed resident construction engineer. Renkin was a Pittsburgh native who, in his lifetime, held high positions in various companies such as the Quigley Fuel Company (New York), the A.M. Byers Company

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[11] R.M. Lala, *The Creation of Wealth: The Tata Story*, paperback edition (Bombay: IBH, 1981), Chapters I and II. The quote is from p. 20.

[12] 'Dr. Charles Perin, Engineer, 75, Dies', *New York Times*, 17 February 1937, p. 21.

[13] Lala, *Creation of Wealth*, p. 20; R.M. Lala, *The Romance of Tata Steel* (New Delhi: Penguin/Viking, 2007), p. 62. For the date of Jamsetji's trip and the duration of Perin's association with the Tatas, see ' "C.P." ' in *TISCO Review,* April 1937, p. 255. Several issues of *TISCO Review* and *TISCO News* were consulted at the Tata Steel Archives, Jamshedpur, and a few at the Tata Central Archives, Pune.

[14] Lala, *Creation of Wealth*, pp. 20-3; C. Minot Weld, 'The Beginnings of the Tata Iron & Steel Company', *TISCO Review*, November 1933, pp. 2-8. The Tatas had been led to iron ore deposits at Gorumaishini by P.N. Bose, formerly of the Geological Survey of India and at this time state geologist of Mayurbhanj, the princely state in which the deposits were located. Jogesh Chandra Bagal, *Pramatha Nath Bose* (New Delhi: Sushama Sen on behalf of P.N. Bose Centenary Committee, 1955), Chapter VIII.

[15] Lala, *Romance of Tata Steel*, p. 13.

[16] Lala, *Creation of Wealth*, pp. 21-4; Weld, 'The Beginnings of the Tata Iron & Steel Company'; Verrier Elwin, *The Story of Tata Steel* ([Bombay], n.p.: [1958]) (British Library Shelfmark W 3092), p. 37; Lala, *Romance of Tata Steel*, p. 17, footnote 2; John L. Keenan [with Lenore Sorsby], *A Steel Man in India* (New York: Duell, Sloan and Pearce, 1943), p. 34. Rothermund, *Economic History of India*, p. 61, argues that investing in TISCO afforded wealthy Indians a means of 'showing their patriotism' in a discreet way. These rich Indians included rulers of the princely states, who were under the ultimate authority of the colonial government.

(Pittsburgh), and the Coke Dry Quenching Equipment Corporation.[17] C.M. Weld, who had led the prospecting efforts, stayed on to supervise the work until the arrival of the first in a long line of American General Managers, R.G. Wells, in January 1909.[18] Wells, an expert in the building of iron works, had worked previously in Mariopol in imperial Russia and with the Dominion Iron and Steel Company in Sydney, Nova Scotia (Canada).[19]

A number of British and Indian engineers worked with these Americans. In 1908-9 a Scottish mining engineer, McNeil, was drafted in to assist with the mining of ore, while an English engineer, B.B. Willcox, was engaged to assist C.M. Weld until his departure from Sakchi. Srinivasa Rao, an Indian graduate of the Mysore State Geological School, had, along with Weld, Dorabji Tata and Shapurji Saklatvala (Dorabji's cousin), been a part of the early prospecting expeditions; after his premature death from cholera, another Indian, Vyas Rao, took over the prospecting and geological work. Weld records that the site chosen at Sakchi was surveyed by 'a corps of native engineers' under Willcox.[20] K.R. Godbole, an Indian who had previously worked in the Public Works Department, was made civil engineer responsible for amenities in the township that would be built in Sakchi.[21]

Unsurprisingly, this mixed group of experts had diverse styles of functioning. A contemporary observer, Mrs. B.J.M. Cursetjee, referred to '[w]atchful Weld', '[v]igorous, forceful, impressive Perin', and 'tall, broad-shouldered, active' Sahlin, and indicated that there was some friction: 'What a struggle between blustering, bullying Renkin who wanted work pushed at any cost and patient, white-turbaned, methodical, Godbole.'[22] Axel Sahlin found Godbole something of a curiosity, writing: 'the Tata Co. have a Civil Engineer, Mr. Codbole [sic], who is a Brahmin of high caste. I do not know how many washings it will take him to get clean after he has associated with us an entire day.'[23] These minor clashes notwithstanding, work progressed, and the plant soon became operational, producing its first steel in 1912. The plant was built with a capacity of 72,000 tons of finished steel per year. The machinery installed, which had been purchased in America and Germany, comprised two blast furnaces (capacity 175 tons per day), four Siemens-Martins open hearth furnaces, a blooming mill, a rail and beam mill, two bar mills, and 180 Coppee coke ovens.[24]

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[17] Weld, 'The Beginnings of the Tata Iron & Steel Company', p. 5; 'The Late Mr. W.O. Renkin', obituary appearing in *TISCO Review*, December 1943, p. 242. Sakchi was renamed at the end of World War I. Lala, *Romance of Tata Steel*, p. 29.

[18] Weld, 'The Beginnings of the Tata Iron & Steel Company', p. 8.

[19] F.R. Harris [with Lovat Fraser], *Jamsetji Nusserwanji Tata: A chronicle of his life*, 2nd edn (Bombay: Blackie & Son, 1958), p. 203.

[20] Weld, 'The Beginnings of the Tata Iron & Steel Company' (the quoted words are on p. 5); Lala, *Creation of Wealth*, Chapter II.

[21] See Lala, *Romance of Tata Steel*, p. 20.

[22] B.J.M. Cursetjee, quoted in R.M. Lala, *Romance of Tata Steel*, p. 20.

[23] Axel Sahlin, 'Personal Impressions of India: Written for his friends by Axel Sahlin: January 15th to April 21st, 1908', p. 24. Booklet consulted at the Tata Steel Archives, Jamshedpur (hereinafter TSA).

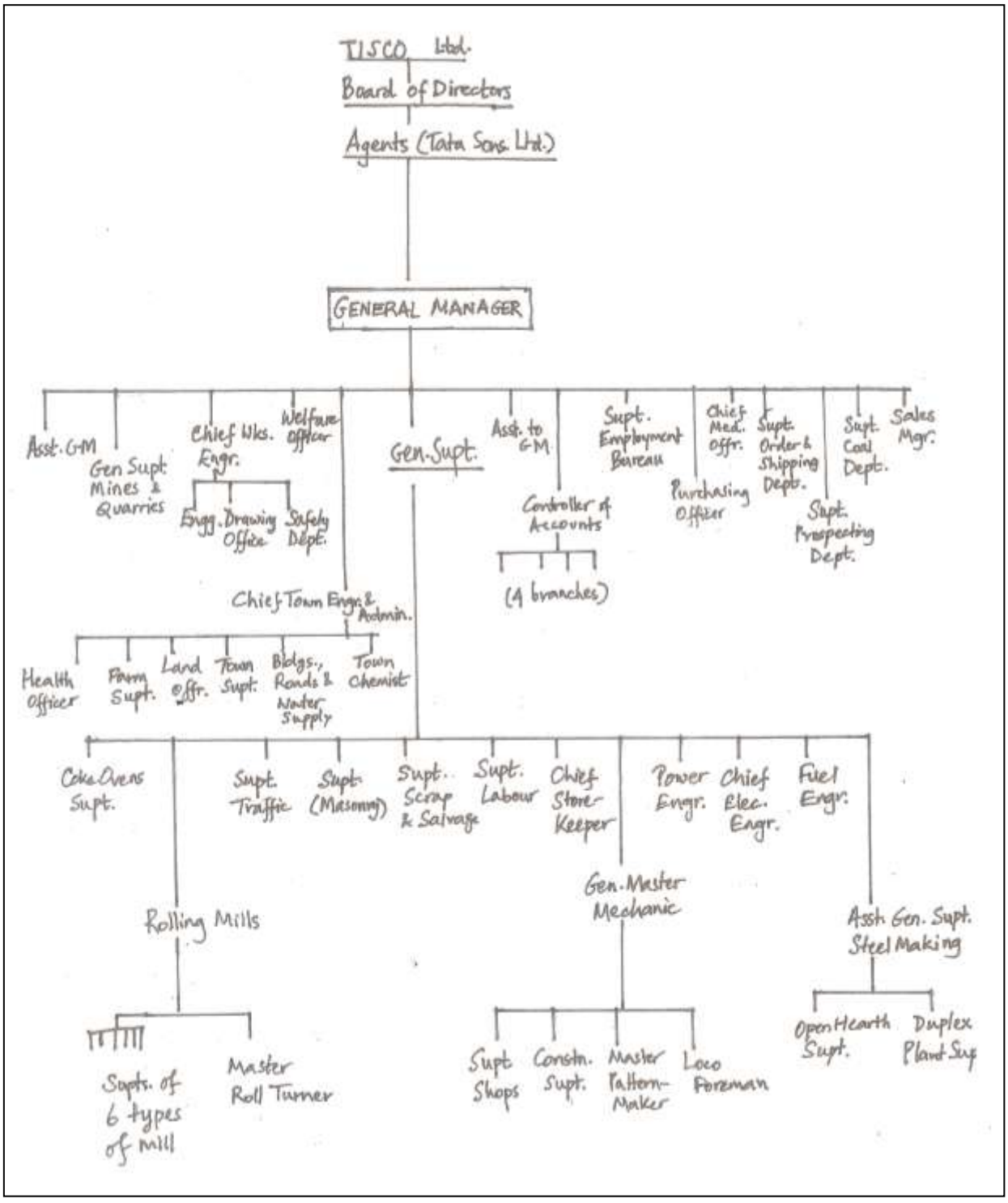
[24] 'The Tata Iron and Steel Company Ltd. 1907 to 1934', *TISCO Review*, Nov 1934, p. 718ff, here p. 718 and p. 722; Headrick, *Tentacles of Progress*, p. 291.

Foreign consultants and technical advisers continued to be important after the inauguration of the plant. When problems were faced with the open hearth furnaces just before World War I, Charles Perin came to Jamshedpur along with Ralph Watson, an open-hearth expert whose services were lent to him by the Carnegie Steel Company, and the furnaces were set right.[25] Perin was also a critical figure during the Greater Extensions programme, an expansion of the plant that began in 1916, aiming to raise the works' output by a factor of five.[26] In his New York office, Perin took on two new partners, and employed 300 engineers and draftsmen, sending 700,000 tracings and 3 million blueprints to India in the years 1917-20.[27] In the interwar years, the company employed as its Technical Advisor a British expert named Richard Mather.[28] Born in 1886, he had been educated at Sheffield University, worked at the Ormsby Iron Works in Middlesborough, done metallurgical research for the British War Office in Woolwich, and been Metallurgical Inspector to the Government of India before he joined the Tatas.[29]

Meanwhile, the second major category of technical experts arrived in Sakchi around 1910. These were the superintendents and managers who would run the various production and support departments. From Figure 1 below, which gives an idea of the organisation structure of the works in the interwar period, we may estimate that they numbered in the range of 20 to 30. Initially most of them were foreigners. These experts, in addition to skilled workers from various foreign countries, made up a foreign contingent of about 175 in an overall workforce of around 2,000.[30]

[25] Keenan, *Steel Man*, pp. 42-3.
[26] Lala, *Romance of Tata Steel*, pp. 36-37.
[27] Lala, *Romance of Tata Steel*, pp. 37-9; Keenan, *Steel Man*, p. 68.
[28] Mather's designation as given in a letter from TISCO (signature illegible) to S.R. Dongerkeri, Registrar of Bombay University, 30 November 1937, Folder: D-51, Box 51: Private Papers, R. Mather, TSA.
[29] Cutting of entry on Mather in *Illustrated All-India Trade Directory and Who's Who*, 1942. Enclosed with letter from Barque and Company, Lahore (publishers of the *Who's Who*), 20 January 1943, inviting him to make changes if required for the 1943 edition. Folder: D-51, Box 51: Private Papers, R. Mather, TSA.
[30] This was in addition to several thousand unskilled labourers recruited locally. Harris [with Fraser], *Jamsetji Nusserwanji Tata*, p. 202; Lala, *Romance of Tata Steel*, p. 27.

Figure 1: *Organisation structure of TISCO, interwar period* [31]



[31] Abridged from undated diagram titled: 'A Chart showing the Organisation of the Staff, both administrative and departmental with the monthly Expenditure of each Dept.', courtesy Tata Steel Archives, Jamshedpur. That the chart refers to the interwar period is inferred based on the expenditure figures marked on the original chart. For example, expenditure under General Manager (all or most of which would have been his salary), is marked Rs. 7,500—which is broadly commensurate with the average salary figures in Table 1 below (those figures include bonuses).

All the foreigners, irrespective of designation, were employed on renewable contracts and referred to as 'covenanted' staff. The term referred not to a particular officer grade but to the terms of employment, thus covering both technical experts (officers) and skilled workers (operators). It was not used for Indians.[32] However, like their counterparts in the government services, TISCO's covenanted employees were paid high salaries (in particular, they earned more than the few Indians who reached the same positions, as shown later in this paper) and granted other benefits such as company housing. Bachelors were housed together in company-built bungalows or lodged at a local hotel, while those who were married had independent houses.[33] A race course was set up for the entertainment especially of the imported staff, whose sporting adventures were made possible by their high salaries.[34]

Like the construction engineers before them, the covenanted employees were drawn from several countries. During his extensive travels many years earlier, Jamsetji Tata had formed views on the strengths of various nations in particular aspects of steel-making. He had communicated these views to his son, suggesting that workers for the plant's departments be sourced according to these strengths.[35] Visiting the works in 1911, the journalist Lovat Fraser reported a division of labour that followed this advice:

> Mr [R.G.] Wells [of the USA] was General Manager, and his chief assistants in the management, as well as the Blast Furnace Superintendent and his staff, were all Americans. The crew of the steel works [open hearth furnaces] and their superintendent were Germans. The superintendent and crew of the rolling-mills were English. The clerical staff was chiefly composed of Bengalis and Parsees, and there were a few extremely efficient Parsees in the various mechanical departments. There were a certain number of Austrians, Italians, and Swiss, while Chinese were working as carpenters and in the pattern-shops.[36]

It appears that the superintendents of each department brought along workers from their respective countries to form their crews. Thus the blast furnace department had a group of steel operators from eastern Pennsylvania, probably schooled in the mills of Pittsburgh, while the German head of the open hearth department (according to the possibly biased testimony of an American superintendent) even selected for an important position 'a man who had had no steel-making experience at all; he had, however, been an officer in the Kaiser's own regiment.'[37]

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[32] For the detailed argument showing that 'covenanted' at TISCO referred only to foreigners, see Ramnath, 'Engineers in India', p. 180, n. 58.
[33] Keenan, *Steel Man*, p. 38; Lillian Ashby (with Roger Whately), *My India: Recollections of Fifty Years* (Boston: Little, Brown and Company, 1937), pp. 359-60. Lillian Ashby's husband Robert was a high-ranking police officer in Jamshedpur in the interwar period.
[34] Ashby, *My India*, p. 298; Keenan, *Steel Man*, Chapter 3.
[35] Keenan, *Steel Man*, p. 38; also mentioned in Headrick, *Tentacles of Progress*, p. 371, citing Keenan.
[36] Harris [with Fraser], *Jamsetji Nusserwanji Tata*, p. 202.
[37] Keenan, *Steel Man*, pp. 38-40. The quote is from p. 40.

As was already evident to Lovat Fraser in 1911, the plant at its highest levels was managed almost exclusively by American experts schooled in the steel industry of their home country. In its first three decades, TISCO's General Managers were engineers or steel experts from the USA. The General Manager was the most important functionary in Jamshedpur, having charge of the entire operation of the works and the township. As an experienced construction engineer, R.G. Wells, the first General Manager, was a suitable choice for the early years when the works were being built and inaugurated. His successor, T.W. Tutwiler (General Manager 1916-25), was a veteran of the steel works in Gary, Indiana.[38] John L. Keenan (General Manager 1930-37) was also a former Gary employee. He had worked there under Tutwiler, who recruited him to TISCO in 1913 as a foreman in the blast furnace department. The Irish-American Keenan was born in Roxbury, Massachusetts in 1889. He studied mainly Classics and economics at Boston Latin School and Yale University before he was trained in steel-making on the job, at the Wharton Steel Company of New Jersey and later at the Gary Steel Company. Keenan rose steadily in TISCO, going through various departments: he became in succession Assistant Superintendent (open hearth furnace), Assistant Superintendent (duplex plant), Superintendent (blast furnace) and General Superintendent of the works (in 1926, four years before he became General Manager).[39]

These high-level executives established a brisk, no-nonsense culture in the works. Tutwiler was known for his brusque demeanour. He is reported to have said to the Viceroy Lord Chelmsford (when asked politely if he was the General Manager), 'You're Goddam right'—an answer which nearly precipitated a diplomatic crisis.[40] Tutwiler believed that 'a steel works was no place for weaklings . . . stern discipline, punctuality and hard work were essential to success . . . the right to hire and fire and lay down the law was a God given right [of the managers].'[41] Keenan comes across in his memoir as a tough-talking but fair-minded man who preferred a down-to-earth attitude to ostentation. He disapproved of the behaviour of a group of college-educated construction engineers from America who camped in Jamshedpur when the works were being extended. He noted that they

> didn't mix with the American and British steel operators. The old-timers … danced the waltz, two-step and even the Lancers, the newcomers danced the fox-trot, the Lame Duck, and the tango … They disdained our whiskeys and sodas, insisting on cocktails and other poisonous concoctions. The old crowd talked of horses and men; the youngsters of golf, dancing and women; they seemed to regard their stay in India as part of a world pleasure tour.[42]

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[38] Lala, *Romance of Tata Steel*, p. 65; for years of General Managership see entry on Tutwiler in 'Vanguards', http://www.tatasteel100.com/people/vanguards.asp (accessed 1 July 2012).
[39] 'John L. Keenan, 54, Steel Authority', obituary in *New York Times*, 8 Jan 1944, p. 13; 'The Late Mr. J.L. Keenan', obituary appearing in *TISCO Review*, March 1944, pp. 20-1; Keenan, *Steel Man*, pp. 1-3. Keenan was an astute observer, and his 1943 memoir, *A Steel Man in India* (cited above) is an important source on the environment in the TISCO works in the interwar years.
[40] Lala, *Romance of Tata Steel*, p. 65.
[41] J.R.D. Tata, a later Chairman of Tata Sons, commenting in 1956 on Tutwiler's approach, as quoted in Oba and Panda (eds.), *Industrial Development and Technology Absorption*, p. 70.
[42] Keenan, *Steel Man*, p. 82.

The experts at the lower managerial levels came from Europe as well as America, and had varied educational backgrounds: some were university-educated, but many were practically trained.[43] An example is F.K. Bennett (1860-1932), who was born in Sheffield and went to the USA at age 10. Starting as a water boy, he was trained as a roller in the Pennsylvania Steel Company, eventually becoming Superintendent of Rolling Mills there before joining TISCO in 1914. An expert roller, he was Mills Consultant to the company for five years until his retirement in 1928.[44] European experts included Ernest Blaser, a Swiss engineer in charge of the boiler plants,[45] and E.R. Nicholson of Northumberland, who joined the company in 1918 as Master Pattern-Maker, later becoming also Assistant Foundry Superintendent.[46] R.M. Prowse, who was briefly Electrical Engineer at TISCO in the late 1930s, had a background spanning three continents. He was born in Devon, educated in South Africa, and further trained in England and the USA before joining the Tatas.[47]

Foreign-trained Indians

Although the plant relied heavily on foreign experts in the early years, there is evidence to show that this was due more to practical concerns than to any prejudice against Indian engineers. As early as 1909, Axel Sahlin, whose firm built the plant, had mooted the idea of sending Indians to Europe or America for training in steel manufacture. However, the Board of Directors had reservations about the costs involved. An alternative was suggested by Bezonji Dadabhoy, who was associated with an older Tata concern, the Empress Mills (textiles) of Nagpur. Bezonji recalled that at his company a few Englishmen had initially been in charge, and had successfully trained Indians to take over from them. He continued:

> I do not think it would help your Company, though it may help India generally to send out young Indians to the U.S. to study and work in the Steel Works there. I would suggest apprentices being taken up and trained under American Experts, who may be brought out for starting and working the Steel Plant at Kalimati [the name of the railway station near Sakchi].

It was the question of costs that ultimately decided the issue. R.G. Wells, the General Manager at Sakchi, reported that '[u]pon completion of our recent estimate of capital expenditure we came to the conclusion

[43] '[T]he European department heads … Many of them had little or no higher education. They had learned what they knew by doing it.' Keenan, *Steel Man*, p. 137.
[44] *TISCO Review*, December 1932, p. 23.
[45] Keenan, *Steel Man*, pp. 44-6.
[46] 'Mr. E.R. Nicholson', *TISCO Review*, December 1933, p. 20.
[47] 'Obituary', *TISCO Review*, April 1940, p. 291.

that the matter of sending Apprentices [abroad] … should be entirely abandoned.' It might be a good idea in ideal circumstances, 'but the Company certainly has no money to spend for such purposes.'[48]

Nevertheless, a few years later, TISCO was able to recruit from the growing band of Indian engineers and metallurgists who had begun to travel abroad on their own initiative for training. These students had turned to foreign countries as the existing education system in India was weighted too far in favour of 'literary and philosophic studies to the neglect of those of a more practical character.' Some of them received technical scholarships instituted by the colonial government, by private societies or by princely states, while others supported themselves by working alongside their studies.[49]

The USA was a particularly attractive destination. This appears to have been so because it was easier to get industrial apprenticeships (as a supplement to formal education in the universities) in America than in Europe. The Hindusthan Association of America—a body set up by Indians in New York to guide prospective Indian students in the USA—claimed that 'America offers the best of opportunities to foreign students.' Foreigners were free to join American universities as well as the 'annual apprenticeship courses' in American factories. Such practical training was an essential part of a 'scientific and industrial education', and it was only in America that foreign students could obtain such training 'without [being charged] any compensation or premium whatsoever.'[50]

Many such USA-trained Indian experts joined TISCO starting in the 1910s (in addition to some Indians who had been trained in Germany or England). A.C. Bose, who had graduated from the Carnegie Institute of Technology in Pittsburgh, joined the company as a chemical engineer, and eventually became chief chemist in place of an American. D.C. Gupta, a Bachelor of Science from Harvard, joined the open hearth steel department as third furnace hand around the time of the Great War. He later transferred to the coke-oven department, and in two years became its Superintendent. After eight further years in the department, during which the Welsh foremen gave way to Indians, Gupta left to take up the post of Director of Industries for Bihar and Orissa (which he held from 1926 to 1933).[51]

An incident involving Gupta illustrates the importance placed by the management on employees' physical toughness. In his days as an operator in the open hearth department, Gupta earned Tutwiler's

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[48] Various letters in GM's correspondence, April 1909. Participants include General Manager (R.G. Wells), Agents (Tata Sons), and Bezonji Dadabhoy. See sheets 13-26 in Box: General Manager's Correspondence, 1909, TSA. On Bezonji Dadabhoy (Mehta), see 'Sir Bezonji Mehta (1840-1927)', http://www.tatacentralarchives.com/history/biographies/02%20bezonjimehta.htm (accessed 1 July 2012).

[49] Indian Industrial Commission, 1916-18, *Report* (Calcutta: Superintendent Government Printing, 1918), Chapter X, 'Industrial and Technical Education' (quoted text from p. 104); Bagal, *Pramatha Nath Bose*, pp. 91-2; Ross Bassett, 'MIT-Trained Swadeshis: MIT and Indian Nationalism, 1880–1947', *Osiris* Vol. 24 (2009), pp. 212-230. The first of these sources is hereinafter cited as *IIC Report*.

[50] The Hindusthan Association of America [New York City], *Education in the United States of America: For the Guidance of the Prospective Students from India to the United States, Bulletin No. 1, 2nd and revised edn*. (New York City: n.p., 1920), pp. 2-3. British Library Shelfmark: General Reference Collection 8385.a.14.

[51] Keenan, *Steel Man*, pp. 134-5; entry on D.C. Gupta in Record of Services, *India Office List* [annual compendium brought out by the India Office, London] for 1940.

unspoken admiration for an act of physical bravado. On being 'insulted by a big Yorkshire foreman', Gupta had

> said calmly to the man that he had been too long in America to take reflections on his parentage without a fight. The foreman made a pass at him. He dodged and landed a haymaker on the foreman's jaw, putting him out for the count.[52]

In contrast, John Keenan recalled the case of a Bengali, a talented mathematician, whom TISCO had intially rejected 'because he looked ill'. But the company hired him as a coke-oven researcher after he had obtained a degree and two years' industrial experience in Germany. In a few months the new recruit was taken seriously ill and died, apparently unable to take the physical strain. Keenan felt that the management had recruited the unfortunate man 'against their own better judgement.'[53]

In one case, that of J.J. (later Sir Jehangir) Ghandy, the company itself appears to have arranged or supported an Indian's studies abroad.[54] Ghandy (1896-1972) was born and educated in Bombay, completing his B.A. honours (physics and chemistry) at St. Xavier's College in 1916 and his B.Sc. honours in chemistry at Wilson's College the following year. He then underwent a spell of practical training at the TISCO works in Jamshedpur before proceeding to the USA, where he studied Business Administration at Columbia University and Metallurgical and Steel Works Engineering at the Carnegie Institute of Technology (Pittsburgh). He returned to India and TISCO in 1921, this time as Metallurgical Engineer in the mill departments. He became the first Indian General Manager in 1938 and later one of the most important TISCO executives in post-Independence India.[55]

Some foreign-trained Indians were recruited in later decades too. C.S.N. Raju, who joined the company as Assistant Power Engineer in 1934, was a graduate of Madras University and an M.S. in Mechanical Engineering from the Massachusetts Institute of Technology. He had worked in America for two years and been Inspector of Steam Boilers, Madras Government for four years before joining TISCO.[56] S.K. Nanavati (c. 1907-1986), who joined the company in 1932, was British-trained. Nanavati did his B.Sc. at the Royal Institute of Science, Bombay, then took the degrees of B.Met (Hons.) and M.Met at Sheffield, followed by that of Doctor Ingenieur (Metallurgiste) from the University of Brussels

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[52] Keenan, *Steel Man*, p. 134.
[53] *Ibid.*, p. 137.
[54] Both Lala, *Romance of Steel*, p. 69 and Headrick, *Tentacles of Progress*, p. 373, write that Ghandy was 'sent' to America, whereas the other source on him, an obituary appearing in TISCO's newsletter (cited below), is ambiguous on whether Ghandy went to the USA on his own or was sponsored by the company.
[55] 'Sir Jehangir Passes Away: End of an Era', *TISCO News*, May 1972, p. 2, p. 8 and pp. 14-17; Lala, *Romance of Tata Steel*, pp. 68-9.
[56] *TISCO Review*, June 1935, p. 488.

in 1932. Nanavati went on to become TISCO's General Manager (1961) and its first Managing Director (1970).[57]

The company's management took its time over applications from Indians studying or working abroad, but it also exhibited a degree of flexibility when it felt that a candidate was promising. This is well illustrated by the sequence of events leading up to the appointment of P.N. Mathur, who became one of the most prominent experts in the TISCO works in the 1930s. (Joining the company in 1927, he became Superintendent of the open hearth plant in 1931 and Superintendent of the duplex plant some months before his death from pneumonia in 1940.)

Born in Lahore, Prem Narain Mathur (1892-1940) had dropped out of medical college and made his way to the USA c. 1913. There he got himself into the Ford Motor Company at Detroit, completed a correspondence course in Metallography, and took practical classes in the YMCA night school. He was placed in Ford's research laboratory, and over the following years made a name for himself as an expert metallurgist.[58]

A little more than a decade after he had first arrived in America, Mathur decided to move back to India. He began corresponding with the Tatas in October 1924, writing first to Dorabji Tata and then several times to John Peterson, Director of TISCO, applying for a job. In March 1925, favourably impressed by Mathur's credentials, Peterson suggested to T.W. Tutwiler (the outgoing General Manager, who was returning to America) that he should meet Mathur in America and report on him. Meanwhile Mathur was asked to specify his terms, and to furnish details of his personal background. He insisted that pay was not an important criterion, but when pressed, quoted a figure of Rs. 1,500 per month. Tutwiler gave Mathur a glowing report after meeting him in September 1925 (he particularly approved of the fact that Mathur seemed 'like he would be willing to take off his coat [and] jump in'). However C.A. Alexander, the new General Manager, felt that the company might not be able to afford Mathur's asking salary. Thereafter the matter appears to have stalled, despite a further query from Mathur. In January the following year Mathur, now working as Assistant Superintendent in the open hearth department at Ford, wrote to Peterson again. 'What I stand in need of', he wrote, 'is a chance in India. If shown this favour I would be able to work out my destiny as wellin [sic] India as I did in America.' Finally, some months later, the Board of Directors empowered the General Manger to offer Mathur up to Rs. 1,750 per month. In due course he was appointed at Rs. 1,500, and began work at Jamshedpur in late 1927.[59]

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[57] 'Veteran Steelman [sic] Passes Away: Shavak Kaikhushru Nanavati', *TISCO News*, Jul-Aug 1986, p. 23.

[58] Capt. B. Dayal, 'Prem Narain Mathur (An Appreciation)', *TISCO Review*, May 1940, pp. 390-2. That Mathur enjoyed a strong reputation as a metallurgist is apparent from the many character references he furnished to TISCO. See the correspondence in Mathur's papers, cited below.

[59] Several letters and a note 'For Favour of Minutes' (date 13 December 1927, title 'SUMMARY – Appointment of Mr. Prem Narain Mathur'), Mathur Papers, TSA**.** The quotes are from the following letters: Tutwiler to Peterson, 20 September 1925; and P.N. Mathur to John Peterson, 20 January 1927.

The Jamshedpur Technical Institute: Indianising the TISCO works

Although Indians were already being recruited in the 1910s, TISCO soon felt it necessary to systematise the process. During and especially after World War I, the company decided to take into its own hands the training of Indians for supervisory and managerial positions. A number of factors made this a priority.

First, there was a pressing need to reduce costs. The covenanted (i.e. foreign) employees in the works were paid hefty salaries and production-based bonuses. Table 1 shows that their average annual pay (including bonuses) was many times that of the Indian uncovenanted staff. It must be noted that this is not a like-for-like comparison (the uncovenanted category included several levels of staff from skilled to unskilled labour, whereas the covenanted staff comprised members of the operating crews, supervisors, and managers). Nevertheless, the comparison shows that covenanted staff were an expensive resource. Further, their numbers dipped between 1912-13 and 1921-22, even as their average income quadrupled, indicating that while foreign workers could be replaced, the expensive managers and experts were still indispensable.[60] There were other overheads. The foreigners were also provided with benefits such as housing and passages from and to their home country;[61] and replacements had to be found for the German open hearth team, whose members were interned in Ahmednagar as enemy aliens when World War I broke out. Furthermore, the company was supplying the Government in excess of 20,000 tons of steel rails per year (at reduced prices) as railroads were built in the battlefields of Mesopotamia, and efficient production was the order of the day.[62] It was apparent that savings could be made if it were possible to find Indians who could attain the higher positions currently occupied by covenanted staff; when an Indian did so, he would be paid a maximum of two-thirds the salary drawn by a foreigner at the same level. This distinction was of a similar order to that between Britain- and India-recruited engineers in the PWD and Railways.[63]

[60] It should be noted that the numbers of covenanted workers rose again in the 1920s, but this should be seen against the massive expansion that the plant was then undergoing. According to Daniel Headrick, the highest number of foreigners was reached in 1924. Headrick, *Tentacles of Progress*, p. 372.

[61] Headrick, *Tentacles of Progress*, p. 371.

[62] Ray, *Industrialization in India*, p. 83; Ashby, *My India*, p. 299; Keenan, *Steel Man*, p. 14 and p. 45; Copy of letter from T.H. Holland to T.W. Holderness (Under Secretary of State for India) dated 21 August 1918, in Indian Tariff Board, *Evidence recorded during enquiry into the steel industry, Volume I: The Tata Iron and Steel Company* (Calcutta: Superintendent Government Printing, India: 1924), pp. 96-7. The last of these sources is hereinafter cited as ITB 1924.

[63] Evidence of J.C.K. Peterson, T.W. Tutwiler and R.D. Tata at Jamshedpur, 18 August 1923, to the Indian Tariff Board, ITB 1924, p. 275ff, here p. 280. The similarity with government service was noted by the President [of the ITB] during this interview. *Ibid.*

Table 1: *Covenanted and uncovenanted employees of TISCO in various years*

Number and average pay (aggregate of coke ovens, blast furnaces, open hearth, blooming mill, 28" mill and bar mills)

Year	Covenanted employees	Total wages and bonus (Rs.)	Average annual pay (covenanted) (Rs.)	Uncovenanted employees	Total wages (Rs.)	Average annual pay (uncovenanted) (Rs.)
1912-13	140	4,59,714	3,284	3,917	8,63,144	220
1915-16	75	6,37,784	8,498	4,243	11,20,284	264
1921-22	74	9,64,592	13,035	9,924	29,79,948	300

Source**:** Calculated from tables in Indian Tariff Board, *Evidence recorded during enquiry into the steel industry* (Volume I: *The Tata Iron and Steel Company)* (Calcutta: Superintendent Government Printing, India, 1924)*,* Statement No. I, pp. 109-11. For rates of bonus, see *ibid.,* pp. 198-200.

Note: The figures for number of employees in this table are not strictly comparable with those for the following decade, by which time the extensions to the plant had become operational.

The second factor that encouraged the creation of training facilities for Indians was related to TISCO's postwar plea for economic protection. While the colonial government granted the company's request for interwar protection from cheap Belgian and German steel imports by raising protective tariffs,[64] in return TISCO had to submit to periodic scrutiny by the Indian Tariff Board (ITB). The ITB had to be satisfied that the company was doing all it could to justify the burden on the Indian consumer, who would pay higher prices for steel, and the Indian taxpayer, whose money would be used for bounties granted to TISCO in this period. The company was expected to demonstrate that it was keeping its costs down, and the Tariff Board saw the replacement of expensive foreign employees by Indians as one of the ways to do this.[65] Further, in the opinion of one ITB official, 'there [was] no question in which the tax-payer [was] more keen than the scope for employment of Indians.'[66]

Third, the company had inaugurated a major expansion project in 1916, following upon the government's high consumption of TISCO steel and the establishment of other steel-consuming industries during the war.[67] As we saw earlier, the Greater Extensions aimed to increase the existing output of the works by a factor of five, and over the next few years it commissioned new plants that used

[64] T. Roy, *The Economic History of India*, p. 235.
[65] Evidence of Peterson, Tutwiler and R.D. Tata, ITB 1924, p. 280.
[65] Evidence of Peterson, Tutwiler and R.D. Tata, ITB 1924, p. 280.
[66] See the exchange between Dr. Matthai (ITB) and Mr. Peterson (Tata Sons) in Indian Tariff Board, *Evidence recorded during enquiry regarding the grant of supplementary protection to the steel industry* (Calcutta: Government of India Central Publication Branch, 1925), pp. 102-3. The quote is from Dr. Matthai on p. 103.
[67] Ray, *Industrialization in India*, p. 87.

improved production techniques such as the duplex process.[68] Although more foreign workers were recruited to fill the new crews,[69] importing experts was an expensive option. Consequently, the company needed as many qualified Indians as it could get.

Fourth, university courses in metallurgy, mechanical engineering and electrical engineering were still rare in India. The major engineering colleges at Roorkee, Madras, Sibpur and Poona were primarily intended to produce civil engineers for government service.[70] In the interwar period courses in metallurgy and mechanical engineering began to be offered at privately run institutions such as the Banaras Hindu University and the Bengal Technical Institute, but these were few and far between.[71]

All these factors favoured the establishment of new, in-house training facilities for Indians. They also dictated the form that such training should take: a combination of university-style theoretical learning with practical apprenticeship in the works. As early as 1916, the Tatas initiated an idea for a metallurgical school in Sakchi, offering a course of two years' theoretical instruction and two years' industrial apprenticeship. According to the proposal, the Bihar & Orissa Government would set up the school, the TISCO works would be used as a site for practical training, and students who passed out would add to the industrial manpower of the province, some of them obtaining jobs in TISCO itself.[72] The plan was placed before the Indian Industrial Commission and met with its 'general approval',[73] but, for reasons that are not clear, did not come to fruition. However, it provided the template for a plan that did materialise.

This was the Jamshedpur Technical Institute (JTI). Set up in 1921 under the primary control of the Tatas, it comprised 'laboratories, lecture halls, classrooms and a library'.[74] It was not meant to be a 'trade' or 'industrial' school, the sort that typically admitted boys from an artisanal background and taught them a practical skill like blacksmithy or carpentry, or other semi-skilled factory work.[75] Instead, it was designed to produce employees rich in theoretical knowledge as well as practical experience, who would be fit to take on supervisory and managerial roles in the TISCO plant. The JTI's existence in the interwar period may be viewed as having two distinct phases falling on either side of the year 1935. I will discuss each in turn.

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[68] Lala, *Romance of Tata Steel*, pp. 37-9; Keenan, *Steel Man*, p. 68; *First report of the Indian Tariff Board regarding the grant of protection to the steel industry* (place and publisher illegible: [1924]), p. 7. (Accessed via Digital Library of India, www.dli.ernet.in, on 2 January 2012.)

[69] Headrick, *Tentacles of Progress*, p. 372.

[70] Arun Kumar, 'Colonial Requirements and Engineering Education: The Public Works Department, 1847-1947' in Roy MacLeod and Deepak Kumar (eds.), *Technology and the Raj: Western Technology and Technical Transfers to India 1700-1947* (New Delhi, Thousand Oaks and London: Sage, 1995), pp. 216-232.

[71] Table 5 below has more on the courses offered at these two institutions.

[72] Evidence of F. Walford, Witness No. 40, in Indian Industrial Commission (IIC), *Minutes of Evidence 1916-17, Volume I: Delhi, United Provinces and Bihar and Orissa* (Calcutta: Superintendent Government Printing, 1917), pp. 316-8.

[73] *IIC Report*, p. 133, paragraph 172. It must be noted here that one of the Commission's members was Dorabji Tata, Chairman of Tata Sons (*ibid.,* p. xvi), although it is not known if he participated in this particular decision.

[74] Keenan, *Steel Man*, p. 135.

[75] See Evidence of F. Walford in IIC, *Minutes of Evidence*, p. 315, on the nature of 'industrial schools'.

The JTI's first phase: the three-year programme

In the first phase of its existence, 1921-34, the Jamshedpur Technical Institute ran a three-year training course for students of university-going age. The structure of the course and the selection of staff and students were such as to enable a combination of scientific education and hands-on work. The instructors were university-trained men, including two (presumably British) Assistants, both Bachelors of Metallurgy from Sheffield, and an Indian B.Sc. (Calcutta). The Director of the Institute, W. Saunders, also had a Sheffield connection: he had been an apprentice at Vickers Ltd. in that city, in addition to holding a B.Sc. from London.[76] It is not clear whether the search for senior staff included the USA and other countries, but correspondence of the time confirms that advertisements were placed in the *Times* in Britain and 'private enquiries' made at British universities.[77] Some years later, the British instructors were joined by Indians who played important roles in the running of the JTI. S.N. Roy, one of the students of the JTI's 1922 batch, joined the staff of the Institute briefly upon graduation.[78] Continuing the Sheffield motif, he was then sent with a scholarship from Dorabji Tata to Sheffield University, where he earned a B.Met. degree before returning in 1928 to take up the post of Instructor at the JTI.[79] Roy later went on to become Superintendent of Training (i.e. head of the JTI).[80] Another Indian who took a keen interest in the Institute was P.N. Mathur, who in his days at Ford had conducted classes in Metallography for his colleagues. Mathur served as President of the Technical School Committee.[81]

As for students, the JTI invited applications from school-leavers with a science background: candidates had to have passed the Intermediate Science (I.Sc.) examination (administered at the end of a two-year course between school and university levels). These students would naturally be literate in English and of university standard. No prior factory experience was required, as the JTI's course itself provided for in-depth practical learning.

In the first two years of the three-year course of instruction, students alternated between the Institute (where they were instructed in theoretical subjects) one week and the TISCO works the next

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[76] Statement No. IX , ITB 1924, p. 121.

[77] [H. Treble] to S.M. Marshall, TISCO, 24 March 1921, Folder: T1/A1, 1921 to 1960, Box: Technical Training, T1/A1 (1921-60), A1 (1962-4, 1965-8, 1966-84), TSA.

[78] Statement 108, Enclosure (2), *The applications received by the Indian Tariff Board from the Tata Iron and Steel Company, Limited, and other companies in connection with the Statutory Enquiry regarding the grant or continuance of protection to the Steel Industry in India after the 31st March 1927, together with the questionnaires issued by the Board and other relevant papers* (Calcutta: Government of India Central Publication Branch, 1926), p. 160. This source is hereinafter cited as ITB 1926.

[79] W. Saunders, JTI Director, to the TISCO General Superintendent, 26 October 1927; S.N. Roy (in Sheffield) to JTI Director, 13 November 1927. Both letters in Folder: T1/A1, 1921 to 1960, Box: Technical Training, T1/A1 (1921-60), A1 (1962-4, 1965-8, 1966-84), TSA.

[80] See S.N. Roy's designation in several memos/ letters sent by him in 1937 and 1938 in B.K. Mukherjee File, Folder: 1937, Box: Technical Training: A & B Class Apprentices, 1937, '38 and '39 batches, TSA.

[81] Capt. B. Dayal, 'Prem Narain Mathur (An Appreciation)', *TISCO Review*, May 1940, pp. 390-2; Keenan, *Steel Man*, p. 139.

(first as observers, then as apprentices). In the third year, having gained a firm theoretical knowledge base, they were apprenticed full-time to the works. During their practical training students reported to the Works Superintendent, while their overall responsibility was to the Institute. After the second year, students decided to specialise in a particular branch of steel-making: coke ovens, blast furnace, open hearth, or sometimes rail mills.[82] The steel expert in the making was expected, from this point on, to concentrate all his energies on his chosen specialism. He had to familiarise himself with 'all the technical literature ever published in England, Germany, France and the United States, so that he becomes a sort of walking encyclopedia on [his chosen subject]', able to answer any question put to him by the superintendent to whom he was apprenticed in the works. In time the student must be able to recall relevant information at a moment's notice, for '[b]y the time he [had] a second thought in an emergency, he may be too dead to need it.'[83]

Like the other steel experts, the students of the JTI had to be in excellent physical condition: the ability to spend long hours in the works in high temperatures and potentially dangerous situations was as important for potential officers as it was for the plant's workers. To this end a medical examination was an important part of the selection process for entry to the Institute. Further, in promoting students from one year to the next, special consideration was given to students who were physically tough and industrious in the plant even if they were below par in their theoretical studies.[84] Students were also encouraged to play sports in their free time.[85]

The JTI was not a profit-making organisation but one designed to train employees for the TISCO works, moulding them according to the company's needs. The students were charged no fees, received a stipend of Rs. 60 a month, and were given subsidised lodging. The company provided them with the necessary books, which they paid for later if they were selected for a job in the works upon graduation.[86]

Although it was run primarily by the Tatas, the Institute received financial support from some provincial governments during the first decade of its existence (see below). Table 2 shows details of the costs of running the JTI, and external contributions, in the first two years of operation (1921-2 and 1922-3). The governments of Bihar and Orissa (Rs. 25,000 per annum) and Bengal (Rs. 10,000 per annum) were the major contributors. The princely state of Mysore sent a few students, paying Rs. 2,000 per student; the Calcutta engineering firm of Bird & Co likewise paid for one student's training. (They were investing in personnel for their own use: sponsored students returned to work in Mysore state and Bird respectively after their training.[87]) Officials of the provincial governments also participated in the first

[82] Evidence of Saunders, JTI Director, in ITB 1924, pp. 302-5; Keenan, *Steel Man*, pp. 135-6.
[83] Keenan, *Steel Man*, p. 136.
[84] See Saunders's evidence, ITB 1924, p. 303.
[85] Keenan, *Steel Man*, p. 135.
[86] Saunders's evidence, ITB 1924, p. 304.
[87] For examples of students transferred to Mysore Distilleries and Bird & Co upon graduating from the JTI, see Statement No. 108, Enclosures (1) and (2), ITB 1926, pp. 159-60.

stage of selection. Saunders, the Director of the JTI, reported that the Directors of Industries in Punjab and Madras examined candidates from their respective provinces and sent the best qualified ones on to Jamshedpur, where they came before a Selection Committee for a further round of elimination and a medical examination.[88]

[88] Saunders's evidence, ITB 1924, p. 303.

Table 2: *Expenditure on and contributions to the Jamshedpur Technical Institute in its first two years*

	1921-22 (Rs. – Annas – Paise)	**1922-23 (Rs. – Annas – Paise)**
Recurring expenditure	42,710 – 5 – 0	71,009 – 3 – 3
Contributions		
Mysore	4,800 – 0 – 0	4,800 – 0 – 0
Bihar & Orissa	8,333 – 5 – 4	25,000 – 0 – 0
Bengal	-	10,000
Bird & Co.	-	1,375 – 0 – 0 *
Sir Ratan Tata Trust	-	15,000 – 0 – 0
Remainder, borne by Steel Company	29,576 – 5 – 8	14,834 – 3 – 3
Actual Capital Expenditure	1,30,519 – 4 – 8	11,277 – 0 – 8
Receipts from Bihar & Orissa	1,00,000 – 0 – 0	-
Remainder, borne by Steel Company	30,519 – 4 – 8	11,277 – 0 – 8

Source: Indian Tariff Board, *Evidence recorded during enquiry into the steel industry, Volume I: The Tata Iron and Steel Company* (Calcutta: Superintendent Government Printing, India, 1924), Statement No. IX, p. 121.

*This figure is marked 'No stipend' in the source. This probably means that the amount paid was sufficient to cover the expenses of the student sent by Bird & Co., but did not include a stipend for the student.

The provinces' decision to contribute monetarily to the Institute may be understood in the light of the constitutional reforms of 1919, which had introduced the system of dyarchy, and made Industries a 'transferred' subject under provincial ministers.[89] Possibly the provincial governments wished to promote the JTI as an opportunity for industrial training for their candidates (some seats were reserved for candidates from donor provinces). Certainly in the case of Bihar and Orissa, technical colleges of the province sent their students to the JTI and TISCO to complete the apprenticeship component of their course. These students were also paid stipends and in some cases employed in the works at the end of the apprenticeship, but their programme of training was distinct from the regular three-year course of the JTI.[90] It will be recalled that the Bihar government had itself originally planned to establish a new institute, the students of which would undergo practical training at TISCO. It is plausible that by contributing monetarily to the JTI, they were seeking to achieve a similar objective at a lower cost.

From the start the JTI (and the prospect of TISCO jobs afterwards) proved immensely popular. The aim was to select around 25 students each year,[91] but the demand for places was many times greater.

[89] A.Z.M. Iftikhar-ul-Awwal, *The Industrial Development of Bengal: 1900-1939* (Delhi: Vikas Publishing House, 1982), p. 59.
[90] Files of various students, Box: Technical Training: Bihar & Orissa Apprentices, 1927-33 Batches, TSA.
[91] Saunders's evidence, ITB 1924, p. 303.

When applications were invited for entry in the second year of the JTI's operation, more than 2,600 candidates applied from numerous provinces and princely states across India (see Table 3).

Table 3: *Applicants to the JTI for November 1922, by province/ princely state*

Province	**No. of application letters**	**No. of students with good physique and otherwise qualified [i.e. I.Sc. diploma and approved by province]**
Bihar & Orissa	224	23
Bengal	885	64
Central Provinces	57	-
Madras	641	29
Bombay	63	4
United Provinces	173	7
Assam	43	6
Punjab	380	31
Central India	11	1
NW Province	13	-
Berar	1	-
Mysore	53	1
Burma	2	-
NW Frontier Province	11	1
Coorg	8	1
Baroda	4	-
Deccan	9	-
Cochin	14	2
Indore	3	-
Travancore	8	2
Cooch Bihar	2	-
Bikaner	1	-
Ajmer	8	-
Sindh	4	-
Kashmir	14	-
Jodhpur	3	-
Rajputana	3	-
Total	2,638	172

***Source*:** Indian Tariff Board, *Evidence recorded during enquiry into the steel industry, Volume I: The Tata Iron and Steel Company* (Calcutta: Superintendent Government Printing, India, 1924), p. 123.

The Institute was extremely selective. Table 3 shows that only 172 candidates of the 2,638 who applied for admission in 1922 were shortlisted to go to Jamshedpur for an interview. Following the interview, only 29 were finally admitted to the JTI. The programme was challenging, and several students could not keep up with it and had to leave the Institute.[92] Of the students admitted in the 1921 and 1922 batches, only fifty per cent graduated successfully. [93]

***Table 4**: Province-wise origin of JTI students until 1926*

	Graduated (as of 1926)		**In the Institute (as of 1926)**
Province	*1921 batch*	*1922 batch*	*Total (including 1923, '24 and '25 batches)*
Bihar & Orissa	7	4	21
Bengal	2	4	14
Assam	-	1	1
United Provinces	1	-	2
Madras	1	2	7
Central Province	1	-	2
Punjab	1	4	8
Bombay	-	-	3
Total	13	15	58

***Source**: The applications received by the Indian Tariff Board from the Tata Iron and Steel Company, Limited, and other companies in connection with the Statutory Enquiry regarding the grant or continuance of protection to the Steel Industry in India after the 31st March 1927, together with the questionnaires issued by the Board and other relevant papers* (Calcutta: Government of India Central Publication Branch, 1926), Statement No. 108, Enclosure (5): 'Provincial List', p. 163.

The students of the JTI, as we have seen, came from all over the country. Table 4 shows that in aggregate terms, the largest number came from the provinces of Bihar & Orissa and Bengal. These were in a sense the 'home' provinces of TISCO (Jamshedpur was located in Bihar and not far from Bengal); and as we have seen, they both provided grants to the Institute (Table 2) and had places reserved for their candidates. In examining the JTI's figures, Professor V.G. Kale and Sir P.P. Ginwala of the Indian Tariff Board expressed surprise at the low share of students from Bombay (with a reputation as an industrial centre rivalling that of Calcutta).[94] Possibly, alternative industrial opportunities in Bombay (with its textile mills) made the Institute less attractive to its students. In any event, very few applications were received from that province (32 for 1921 and 63 for 1922).[95] Ginwala and Kale's surprise underlines the fact that Bombay was the exception that proved the rule that JTI places were coveted. The company's statement

[92] Saunders's evidence, ITB 1924, p. 303.
[93] Statement No. 108, 'Jamshedpur Technical Institute: Notes on Institute Results', ITB 1926, p. 158.
[94] ITB 1924, pp. 304-5. For full listing of ITB members, see *First Report of the Indian Tariff Board,* p. 2.
[95] Statement No. IX, ITB 1924, pp. 121-2, here p. 122.

furnished in response to their query underlines its high standards and the qualities it prized in applicants. Of the 63 applicants from Bombay for 1922, the statement said, only 4 were selected for the next round. Two of these went to Jamshedpur. One failed the medical examination, and the only one selected, T.R. Kapadia, went on vacation at the end of April 1923 and did not return. The statement concluded drily: 'It appears that he found the work too strenuous.'[96]

From the mid-Twenties, graduates of the JTI were ready to join the various departments and work their way up to the 'the more expert and responsible class of work'.[97] While they were not guaranteed employment in the Tata works, many of those who completed the course successfully were offered contracts. They began at a minimum of Rs. 200 a month, and were contracted for five years in the first instance.[98]

Most of these graduates began as foremen or assistant foremen[99] and moved up into the managerial grades within a few years. In 1926 the company reported that some of the JTI graduates who were now in the works (since 1924 or 1925) had already been promoted;[100] by 1928, three JTI graduates were 'actually operating furnaces'.[101] The rate of ascent through the ranks varied by the individual. One who rose rapidly was S. Sambasivan, who was appointed Chief Inspector in the Inspection Department upon graduation from the JTI.[102] In 1932 he was already Superintendent of the order department (the first JTI graduate to reach that rank).[103] In time others were promoted too. Keenan reported in 1943 that the current superintendents of the open hearth furnaces and the duplex plant were graduates of the first JTI batch.[104]

As early as 1926 the company reported to the Indian Tariff Board that 'the contracted men [i.e. JTI graduates] are building up an encouraging reputation which undoubtedly justifies the system being adopted.'[105] The Institute kept up a steady supply of personnel to the works in the following years: as of 1932, the total number of contracts awarded stood at 88.[106] Furthermore, between two and four of the graduates from most years were sent for a further spell of specialised training in particular branches of steel manufacture in plants in Germany and England.[107]

John Keenan further endorsed the competence of the JTI graduates. In 1932, when he was General Manager, the management decided to set the JTI men a challenge. The effects of the Depression

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[96] *Ibid.*
[97] Statement No. 108, 'Jamshedpur Technical Institute: Notes on Institute Results', ITB 1926, p. 158.
[98] Evidence of Saunders and John Peterson, ITB 1924, pp. 302-5.
[99] Statement No. 108, Enclosure (1), 'Statement showing the Designation and Work of the Students who were recruited in 1921 for Metallurgical Apprenticeship and completed the course', ITB 1926, p. 159.
[100] Statement No. 108, 'Jamshedpur Technical Institute: Notes on Institute Results', ITB 1926, p. 158.
[101] Keenan, *Steel Man*, p. 140.
[102] Statement No. 108, Enclosure (1), 'Statement showing the Designation and Work of the Students who were recruited in 1921 for Metallurgical Apprenticeship and completed the course', ITB 1926, p. 159.
[103] *TISCO Review*, December 1932, p. 17.
[104] Keenan, *Steel Man*, p. 135.
[105] Statement No. 108, 'Notes on Institute Results', ITB 1926, p. 158.
[106] TISCO Annual Report for 1931-2 (Directors' Report), p. 8. (Consulted at TSA.)
[107] See section on Technical Institute in Directors' Report, TISCO Annual Report, 1931-2 through 1933-4.

had begun to be felt and the pressure on production was reduced, so it was not critical to keep all the open hearth furnaces as well as the duplex plant running at full capacity. Some of the foreign technicians in the open hearth department were 'sent … home' (presumably this means they were dismissed or did not have their contracts renewed), and others were transferred to the duplex plant. A group of JTI graduates was placed in charge of the open hearth furnaces under the direction of Prem Mathur. 'Within a year', Keenan recalled, 'they were averaging 34,000 tons a month and had set a record for one month of 37,000 tons, or nearly double the American and British Tata record of 1919.'[108]

The JTI's second phase: the graduate trainee programme

Despite the success that attended the JTI's early years, a few problems emerged. To begin with, the inability of many students to complete the three-year programme suggested that despite the strict admission procedure, not all students possessed the required aptitude. Saunders, the Institute's Director, observed in 1924: 'We find that the I.Sc. [Intermediate Science] Indian qualification is not a very high qualification.'[109] To add to this, steel manufacturing in the following years was seen as relying increasingly on scientific theory, which also suggested the need to admit better qualified students. As the Superintendent of Training put it in 1935, 'the days of rule-of-thumb methods in industry have gone by.'[110]

Further, the obligation to take in a certain number of students from donor provinces meant that the Institute's management did not have an entirely free hand in the selection of students. This, Keenan implies in his memoir, was another factor diluting the quality of admitted students.[111] Finally, the JTI sometimes had to take on apprentices from provincial technical schools outside of its regular three-year programme. An incident that occurred in 1931 indicates that the Institute found this arrangement one-sided, especially when its autonomy was challenged. In that year the Orissa School of Engineering in Cuttack sent four of its students to the TISCO works via the JTI for the start of a two-and-a-half-year apprenticeship. Soon after his first communication, Sohan Lal, the Principal of the Orissa School, wrote to amend the list, asking the company to accept a student named Mahadeb Naik in place of K.V. Gopala Rao.[112] While Lal insisted that Gopala Rao had been named '[b]y a mistake',[113] Saunders of the JTI suspected a different motive. Rao, he said in an internal memo, was 'the best of the bunch' sent from the Orissa School, and the Principal now wanted to replace him, 'obviously on second thoughts'. He

[108] Keenan, *Steel Man*, p. 140.
[109] Saunders's evidence, ITB 1924, p. 303.
[110] 'Technical Institute at Jamshedpur: Superintendent's Speech at Annual Prize Distribution', *TISCO Review*, July 1935, pp. 561-2, here p. 561.
[111] Keenan*, Steel Man*, p. 138.
[112] Sohan Lal (Principal, Orissa School of Engineering) to the General Manager, TISCO, 12 January 1931, K.V. Gopala Rao File, Box: Technical Training: Bihar & Orissa Apprentices, 1927-33 Batches, TSA.
[113] Sohan Lal to General Manager, TISCO, 28 January 1931, K.V. Gopala Rao File, Box: Technical Training: Bihar & Orissa Apprentices, 1927-33 Batches, TSA.

suggested that Rao's roots in the presidency of Madras might be the cause of the changed decision.[114] During the ensuing negotiations, the company stressed its right to choose the better candidate (especially as he was the one sent originally), pointing out that it paid the apprentices a stipend for two and a half years (and might employ them at the end). 'In view of the facilities which this Company grants to the students from Ranchi Technical School and the Orissa School of Engineering, we do not think our request is unreasonable.'[115]

In order to address these challenges, the JTI was reorganised substantially starting with the 1935 batch of trainees.[116] The Institute now dispensed with the grants from provincial governments, and 'was free to pick men solely on merit and physical stamina.'[117] The I.Sc. was no longer a sufficient qualification to enter the Institute: the programme was redesigned as a two-year course for graduates.

The Institute was not limited any more to instruction in metallurgy, but also included electrical and mechanical engineering. According to the prospectus for the year 1936-7, students were classified as A1, A2 or B Class Apprentices according to their prior qualifications, as follows:

> B: 'A Degree or Diploma in Mechanical or Electrical Engineering or Metallurgy of a recognised Indian or Foreign University, Technical Institute or College.'
>
> A1: 'An HONOURS or FIRST CLASS Degree or Diploma in Mechanical or Electrical Engineering or Metallurgy of a recognised Indian or Foreign University, Technical Institute or College, preferably accompanied by Works experience ABROAD.'
>
> A2 (the highest class): 'An HONOURS or FIRST CLASS Degree or Diploma in Mechanical or Electrical Engineering or Metallurgy of a recognised Indian or Foreign University, Technical Institute or College, accompanied by not less than 6 months continuous practical experience after graduation in an IRON & STEEL WORKS ABROAD.'

The age limit to apply to the JTI was 27 years for graduates of foreign universities and 24 for those of Indian universities. A2 Class Apprentices could receive a stipend of up to Rs. 200 a month at the discretion of the company. A1 and B Class Apprentices were paid Rs. 75 per month and Rs. 50 per

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[114] W. Saunders to General Superintendent [TISCO], 19 January 1931, K.V. Gopala Rao File, Box: Technical Training: Bihar & Orissa Apprentices, 1927-33 Batches, TSA.
[115] Signed by H. Chew for General Manager, TISCO, to Principal, Orissa School of Engineering, 30 January 1931, K.V. Gopala Rao File, Box: Technical Training: Bihar & Orissa Apprentices, 1927-33 Batches, TSA. TISCO eventually won the argument and the Orissa School allowed Gopala Rao to continue his apprenticeship with the company. Sohan Lal to General Manager, TISCO, 2 February 1931, in the same file.
[116] Superintendent of Training to Superintendent S.M.S.3, 22 March 1961, B.K. Mukherjee File, Folder: 1937 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA. See also Directors' Report in Annual Report for 1934-5, p. 8. (Consulted at TSA.) This is the first Annual Report to mention A and B Class apprentices.
[117] Keenan, *Steel Man*, p. 138.

month respectively. Apprentices also received subsidised housing and 'free medical attention' (under certain conditions). A clause stated that admission would not in any way depend upon a candidate's province of origin or residence.

While the educational qualifications of entrants to the JTI were now higher than in the Institute's first phase and the course of instruction shorter, the programme maintained several of its essential features. As before, the course was a mix of theoretical instruction and practical training in the works.[118] Students passed through a vast number of departments for short periods of time before specialising in the work of any one department, where they would spend six months undergoing training.[119] The emphasis on physical fitness was unaltered: 'Applicants must be of robust physique and be fit to perform hard manual labour'. A student could be asked to leave the Institute if he 'fail[ed] at any time to satisfy the Management in regard to the standard of [his] work, conduct, attendance or health'.[120] In the application forms of several students (archived in their respective files), the entries against 'Proficiency in College Athletics' are specially marked in pencil, probably by a member of the selection committee.[121]

The average number of A and B Class apprentices admitted in each batch between the years 1936 and 1939 (both inclusive) was 13.[122] The educational backgrounds of some of the early graduate trainees, and the jobs they obtained later, are shown in Table 5 below:

[118] TISCO Ltd., 'The Jamshedpur Technical Institute: Prospectus: Session 1936-1937', A.P. Mitter File, Folder: 1937 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA. In addition to the graduate trainee course, the Tatas' apprentice programme, in which sons of employees were trained in trades such as fitting, welding and machining, was merged with the JTI. These students were now termed C Class Apprentices. Keenan, *Steel Man*, pp. 137-8.

[119] See for instance V.M. Subramanian file, Folder: 1937 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA.

[120] TISCO Ltd., 'The Jamshedpur Technical Institute: Prospectus: Session 1936-1937', A.P. Mitter File, Folder: 1937 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA.

[121] Files of students listed in Table 5 below. Sources are the same as those cited for Table 5.

[122] Calculated from figures in Directors' Reports appearing as part of the TISCO Annual Reports for the relevant years (TSA).

Table 5: *Profiles of some graduate trainees, JTI* [123]

Name and province of domicile	**Year of joining JTI (usually January)**	**Class of Apprentice-ship (if known)**	**Prior Qualifications***	**Job held (if known)**
A.P. Mitter (Bengal)	1937	B	Mechanical Engineering (4-year Diploma), **Jadavpur**	--
B.K. Mukherjee (Bihar)	1937	B	Electrical Engineering (Diploma), **Jadavpur**	As of 1961: First Converterman in New SMS.3 Bessemer Converter Section
V.M. Subramanian (Sind)	1937	A1	B.Sc. in Mechanical and Electrical Engineering, **BHU;** G.I.E.E. (membership received while in the Institute)	Assistant Sales Engineer, Wheel Tyre & Axle Plant (as of 1942); Assistant Sales Manager, TISCO, Madras (as of 1946)
U.A. Prabhu (Madras)	1938	B	B.Sc. in Metallurgy, **BHU**	Foreman, C1 Foundry (as of 1948)
N.K. Ganguly (Punjab)	1938	A1	Diploma of Maclagan Engineering College, Lahore (Electrical Engg) and B.Sc. in Engineering, Punjab University	--
K.P. Mahalingam (Bombay)	1942	--	Diploma in Mechanical Engineering, **VJTI**	--
P.V. Ramachandran (Madras)	1942	A1	B.Sc. in Mechanical and Electrical Engineering, **BHU**	Foreman Machine Shops I (as of 1946)

*The full names of the Colleges listed are as follows:
BHU: Engineering College, Banaras Hindu University, Banaras.
Jadavpur: College of Engineering and Technology, Bengal (known as Bengal Technical Institute until 1929), located in Jadavpur near Calcutta.
VJTI: Victoria Jubilee Technical Institute, Bombay.

Table 5 confirms the fact that courses in branches of engineering other than civil were still in their infancy in interwar India,[124] with only a select few colleges operating established courses in branches relevant to industry, such as electrical and mechanical engineering. All students listed in the table except N.K. Ganguly had obtained their degrees or diplomas in colleges that had been set up, and were funded, wholly or partially through private initiative. Indeed the college at Jadavpur had been established in 1906 as a result of the Swadeshi movement's boycott of colleges run by the colonial government.[125]

[123] Files of the concerned students (including correspondence and applications for admission to the JTI), in
i) Folders: 1937 Batch and 1938 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA.
ii) Folders: GT 1941 Batch, Box: Technical Training, Graduate Trainees 1941, '44, '45, TSA.
[124] See Arun Kumar, 'Colonial Requirements and Engineering Education', p. 228.
[125] On Jadavpur, see Jogesh Chandra Bagal, *Pramatha Nath Bose*, Chapter X. On VJTI, see *IIC Report*, pp. 105-6. The moving force behind the setting up of BHU was the Congress leader Madan Mohan Malaviya. BHU's

It appears that B Class Apprentices were expected to become middle level supervisory employees with the possibility of promotion, while A Class students were groomed to attain higher managerial positions (as indicated by the cases of B.K. Mukherjee and V.M. Subramanian in the table). Much, however, depended on the individual and his performance during the course of training (and, naturally, after employment). For instance, although A Class apprentices were usually offered a higher starting salary if employed at the end of the course, a B Class apprentice could in theory be offered the same salary provided his performance in the course reached the standard of an A Class student.[126]

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By all accounts the JTI helped the management successfully Indianise the works. As of 1938-9, 219 students had been trained in the JTI, of whom 202 were working in the company.[127] A recent study by Hiruyoki Oba and Hrushikesh Panda gives the number of covenanted personnel replaced by Indians in the period 1926-33 as 85,[128] a significant number given that the total strength of covenanted personnel in 1925-6 had been 199.[129] It follows that considerable savings were effected, as Indians were less expensive than their foreign counterparts even at the managerial levels. Oba and Panda estimate that expenditure on wages decreased 'by about 50%', which 'thereby led to sizeable reductions in the average cost of production of steel.'[130]

The JTI played an important role in the continued healthy performance of TISCO in the interwar period. With the help of economic protection, TISCO successfully withstood foreign competition, while domestic demand grew as a number of ancillary steel-consuming industries came up in Jamshedpur (e.g. Agricultural Implements Company; Tinplate Company of India, Limited; Indian Steel & Wire Products Ltd.; Jamshedpur Enginering & Manufacturing Co.).[131] TISCO's share of the domestic steel market by volume was 37.3 per cent in 1926; rose to 59.45 per cent (431,000 out of 725,000 tons) in 1932-3, despite a fall in overall demand in the Depression years; and increased further to 66 per cent around the start of World War II.[132] During the war, the company began to produce a wide variety of steel products such as 'armour plates…, alloy, tool and special steels' and 'acid steels for turning out wheels, tyres and axles' for the railways.[133] The JTI did not become the only entry route to TISCO for technical experts—P.N. Mathur being an example of an experienced expert being recruited directly—but it became essential to the

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engineering college was established in 1919. See Institute of Technology, Banaras Hindu University, 'Heritage', http://www.itbhu.ac.in/itbhu/heritage.shtml, accessed 9 June 2012.

[126] See correspondence in U.A. Prabhu file, Folder: 1938 Batch, Box: Technical Training, A&B Class Apprentices, 1937, '38, '39 Batches, TSA.

[127] This would include the three-year students before 1935, and the A and B Class apprentice thereafter. Directors' Report, in TISCO Annual Report for 1938-9, p. 8.

[128] Oba and Panda (eds.), *Industrial Development and Technology Absorption*, p. 73.

[129] Calculated from statements No. 57 to 70, ITB 1926, pp. 115-19.

[130] Oba and Panda (eds.), *Industrial Development and Technology Absorption*, pp. 81-2.

[131] Ray, *Industrialization in India*, pp. 77-8 and pp. 89-90; ITB 1924, p. 74.

[132] R.K. Ray, *Industrialization in India*, pp. 87-8.

[133] *Ibid.*, p. 92.

company's recruitment strategy. The availability of qualified Indian personnel at a rate that the company could determine, through the JTI, was crucial in cutting costs, convincing the government to continue the grant of protection, and running the expanded works after the Greater Extensions had been carried out. In achieving this, the JTI also established itself as one of the earliest industrial training facilities in the country. The three-year programme that it ran in its first phase, starting in 1921, anticipated by at least a decade the introduction of degree courses in mechanical and electrical engineering in most of the government engineering colleges.[134] This suggests that the two-year graduate trainee programme of the JTI's second phase was an exceptionally advanced programme in the context of 1930s India.

Conclusions

This paper has explored the background, training, nature of expertise and work culture of technical experts in the Tata Iron and Steel Company (TISCO) in the interwar period. TISCO, one of the most important industrial enterprises of interwar India, was not only built by American engineers but also staffed by an international group of technical experts from various countries, of which the USA was the most prominent. The culture of steel-making in the company (whose works were inaugurated in 1912) was defined by this multi-national group of technical managers and supervisors, men of physical strength, many of whom had learnt their skills through practical training. When they were joined by a number of Indians—who had attended universities in the USA, Germany and Britain and been industrial apprentices in those countries—the work culture continued to emphasise the importance of practical experience, physical toughness and quick-wittedness in the works.

The Jamshedpur Technical Institute (JTI) was central to the process of Indianisation that was undertaken in the interwar years, as the company sought to cut costs and obtain economic protection from the government. The graduates of the Institute were trained to replace foreign employees at the middle and higher levels of the works' personnel. The most important feature of the Institute's curriculum was its mix of theoretical learning and practical experience—students spent a substantial proportion of their training as apprentices in the TISCO works. Both at its inception, when it trained school-leavers, and from 1935, when it became a training programme for graduates in metallurgy and engineering, the JTI's management continued to prize physical fitness and practical experience in addition to academic achievement. These formed important criteria in the selection of students for the JTI and ultimately for jobs in the works.

This study of industrial experts in TISCO has added a significant dimension to economic histories of Indian industry, in which technical experts have not received adequate attention. I have shown in this paper that in addition to economic protection, the ensuring of a steady supply of Indian

[134] See Arun Kumar, 'Colonial Requirements', endnote 36 on p. 231 for the dates when these degrees were introduced at Poona, Sibpur and Madras.

experts was vital in enabling TISCO to effect savings and perform successfully through the interwar period. Second, the paper has highlighted the importance of extra-imperial networks and influences in the history of industrial engineers in India. The multi-national team of experts who started up the works, American managers, machinery and consulting engineers, and Indians trained in America and Germany were all essential factors in the company's interwar performance. Further, TISCO did not rely on the colonial education system as a source of Indian experts, using instead its own Institute, the JTI, in which many of the graduate trainees were products of a small number of privately run technical/engineering colleges.