UNIT 37 TECHNOLOGY, SCIENCE AND EMPIRE

Structure

37.1 INTRODUCTION

Every society, however crude or primitive it might appear from the benefit of hindsight, has a certain amount of scientific rationality and endeavour within it. The South Asian society, from time immemorial, has nurtured a thinking civilization. It never lived an isolated existence and never displayed xenophobic tendencies. Techno-scientific tradition in South Asia has been largely a synthetic tradition, continuously evolving as a result of each politico-cultural interaction with the outside world and social change within the region (Rahman, 1984). In pre-modern times, South Asia was known for its contribution to astronomy, medicine and mathematics. Centuries ago Said al Andalusi (1029- 70) in his *Tabaqat al Uman* (Probably the first work on history of science in any language) referred to India as the first nation which cultivated the sciences. But it was during the post-Renaissance epoch (that of Rene Descartes (1596-1650) and Issac Newton (1643-1727) that Europe began to outdistances all other culture-areas. In the eighteenth century this distance became virtually unbridgeable. For India, this century proved unique in the sense that it saw the decline of pre-colonial systems as well as the inauguration of systematic colonization. During this period the rise of modern science itself coincided with the rise of capitalism and colonial expansion (Moraze, 1982). Probably they grew in tandem, feeding each other.

Eighteenth century India, however, remained 'blissfully' ignorant of these developments. In the early eighteenth century an *amatya* (minister) of Kolhapur, Ramchandrapant, wrote about the activities of the European traders and 'factors'. He called them *topikars* (hat-wearers) and recognised that their strength lay in 'navy, guns and ammunitions'. His prompt advice was to avoid the *topikars*, 'neither troubling them nor being troubled by them'. This was an early sign of withdrawl and of playing safe. But this attitude tempted the *topikars* to attempt conquest along with commerce and their success was virtually assured. The Indian world-view remained by and large tradition-bound. Even notable exceptions like the scholar-prince Sawai Jai Singh (1688-1743) who invited Jesuits and shared astronomical knowledge with them, could not transcend the cultural limits of his age and people. But there were certain areas in which interaction between the East and the West resulted in acceptance and improvement. These were ship-building, armaments, metallurgy, cloth printing and architecture. European innovations were conveniently ignored wherever .existed an alternative or appropriate indigenous technology which could serve the Indian needs to a reasonable degree (Qaisar, 1982). For example, mechanical clocks, the printing press, telescopes, coal, etc. remained mere curios. Since these were not found culturally compatible, the Indian nobility simply ignored them. While explanations about the acceptance or rejection of a particular idea or tool may not always appear convincing, it nevertheless remains true that the eastern knowledge-corpus and its implements were no match to what was then happening in the West. The problems of eighteenth century India were compounded by an enormous intellectual failure on the part of the ruling class (Athar Ali, 1979). This was true not only of late Mughal India but the Safavids in Iran, the Manchus and the mighty Ottomans had also begun to show signs of crack.

37.2 COLONIALISM AND SCIENTIFIC KNOWLEDGE

Some resurgent nations, now ruling the waves, came in and through their trading companies chalked out large areas. Their sails, their guns, their training were substantially different. They had 'new' knowledge behind them. In the midst of political intrigues, plunder and numerous local wars, some official of the East India Company could think of establishing a forum for knowledge (The Asiatic Society, 1784) and a college at their fort (Fort William College, 1801). Trained surveyors marched along with their armies. The British could succeed against their numerically superior adversaries largely because they possessed a thorough and scientific knowledge of the country through which they marched. In 1760s Rennell surveyed Bengal and later Kelly surveyed the Caratic region. Their charts were of immense value for both military operations and revenue settlements. Survey and expansion moved side by side. Every boat that touched the Indian shores had a medical man on board. Trained in the scientific seminaries of Scotland and Northern Europe, he would be known as surgeon-naturalist: and true to his training, in his spare time, he would look for and report on the topography, minerals, flora, fauna and people of his area. They were scientific soldiers who willingly and promptly extended the help of 'new' knowledge to the process of colonial expansion and consolidation.

Thus was born the phenomenon of 'colonial science'. In some ways, it did represent an advance over pre-colonial science. It was far more systematic, methodical, penetrative and pervasive. It involved everything: science, politics, commerce, military operations, administration, etc. In any case it is now widely acknowledged that techno-scientific developments and colonial expansion had closer links (Headrick, 1981; Deepak Kumar 1995, 2001; Roy MacLeod & Deepak Kumar, 1995). These links beg certain questions. Can there be an imperialist side to the core of natural knowledge? What was the shape that 'modern' and 'universal' science took in a colony? What was the colonial posture in science and to what extent were scientific discourses used to achieve political and cultural goals? No less important is to glean how the recipient culture sought to appropriate or redefine the metropolitan ideology of science. How was the indigenous scientific tradition perceived? How did the local people react to the introduction of 'new' 'knowledge and new tools? Was a synthesis possible? Finally, could the integration of technological and scientific tradition have taken place as part of the natural evolution of the Indian society had colonization not intervened?

Clear answers are difficult to attempt, for colonialism was no monolith and it left several facts and questions open to interpretation in diverse ways. Yet one thing is certain, colonial science lacked sovereignty. Its contours were of course drawn on the colonial terrain, but it enjoyed a rather limited autonomy which was further reduced as the colonial grip tightened. Several colonial scientists felt uncomfortable, yet they had to perform a dual role-to serve the colonial state and to serve science. This state claimed superiority in terms of structure, power, race, etc. Science claimed superiority in terms of knowledge and inter alia helped the colonial state dismiss 'other' epistemologies. Both needed each other and became mutually dependent.

37.3 DUAL MANDATE

As the Company rule in India owed its origin primarily to mercantilist activities, the notion of 'science for profit' makes an early appearance. Yet, in the early stage, the colonial scientists (those days mostly surgeon-naturalists) had more freedom and flexibility. There were many difficulties but also enormous opportunities to discover and sight new things. Support from metropolitan scientists added to their confidence and their agenda was not entirely derivative. They did enjoy a certain amount of autonomy and they too influenced metropolitan discourses (for example, on the deposition of coal-seams, nature of cholera, etc.). Richard Grove has shown that the idea of environmental conservation came from the colonies, and colonial planters, botanists and foresters contributed a great deal to the initiation and maturation of conservation debates in the metropolitan circles. Moreover, the very concept of a state scientist emerged in the colonies and this shows how aware the trading companies, who ran the colonial business, were of the importance of scientific explorations. A knowledge of the local terrain, local resources, customs and traditions was vital for the founding of a colonial state. The process of acquiring this knowledge was not an easy one; almost insurmountable physical and conceptual problems came in the way.

The early colonizers in India realized that they had to tread cautiously. The state they sought to establish had to adapt to, and yet be substantially different from, the pre-colonial structures of power. In order to legitimize their own rule, they first had to delegitimize several pre-colonial structures and texts. For this, the condemnation of the immediate past was considered necessary. Indians were declared unscientific, superstitious and resistant to change; India was 'identified with dirt and disease'. Travellers, scholars and officials of both the Orientalist and Anglicist variety subscribed to this view. William Jones, the foremost Orientalist, declared that in scientific accomplishments the Asiatics were 'mere children' when compared with the Europeans (Adas, 1990). Thus was established a paternalistic Raj which would be caring and dismissive at the same time. It was to be based on claims to not only superior musketery, but to a superior knowledge as well. This sense of superiority came from western discourse on rationality and progress, and was promptly used to denounce whatever scientific knowledge e.g. in astronomy and medicine the Indians could boast of. Yet this denunciation was not total. Several early colonial scholars showed respect for certain indigenous scientific traditions and techniques. They wanted western knowledge to permeate slowly and cause gradual displacement.

There were certain individuals on the spot who largely determined what was advantageous to (both trade as well as the country. Thus James Rennell (Surveyer

General of Bengal who surveyed and mapped Bengal), Thomas Kyd (English Elizabethan dramatist 1558-1594), Roxburgh, William Carey (Baptist missionary to India, 1761-1834), John George Lambton (1792-1840, British statesman who played an important role in drafting the reform bill of 1832), Williams, O'Shaughnessy and others emerge as pioneers. These colonial scientists tried their hand in several fields simultaneously and were in fact botanists, geologists, zoologists, physicists, chemists, geographers and educators-all rolled into one. For example, while seeking lecturership at the Calcutta Medical College, West Bengal, O' Shaughnessy offered not only to teach chemistry and experiment with medical plants but also to give practical instructions to non-medical as well as Indian and European students, on the chemical arts of dyeing, bleaching, calico-printing, distilling, sugar-refining, melting of ores and manufacture of drugs'. This had its positive as well as negative points. As data-gatherers they had no peers; but for analysis and recognition, they had to depend on the metropolitan scientific culture whose offshoots they were and from which they drew sustenance.

37.4 ORGANIZATIONAL IMPERATIVES

An impressive institutionalization alone could have consolidated the gains that accrued from the exploration. It may be interesting to observe how and in what form a particular scientific organization at a particular historical juncture worked for the then existing politico-economic structure. Geological and survey department, for instance, received the maximum patronage from the government. Next ranked botany. Agriculture remained a Cinderella till the 1890s, though a few private agricultural and horticultural societies did try to give it a commercial drift. Private scientific bodies were often more vigorous than the government machinery itself. Among them can be counted the Asiatic Society of Bengal, the Bombay Branch of the Royal Asiatic Society and the medical and physical societies. in Presidency towns. Changing economic needs, the proliferation of scientific establishments, and the growing concern shown for them by the educated Indians made the government to think in terms of an apex body to regulate scientific affairs in India. In 1898, at the instance of the Home Government, the Royal Society formed an Indian Advisory Committee, and in 1902 the Government of India established a Board of Scientific Advice. These experiments unfortunately generated more heat than light and ended in a whimper. Still these institutions had brought the government, science, and economic consideration into a close relationship. The economic interest-group desired research to gain immediate and practical ends. The economic ramification can well be spotted in the growth of industries fed on applied science, viz. coal, cotton, jute, tea, etc. One may argue that scientific development in British India should be treated as individual romances with natural history without linking them with the political economy of the time. But where would be natural sciences without industry and commerce? The light of science had certainly been dimmed by the smoke of commercialism.

Excessive government control of scientific undertakings often hampered the logical development of modern science in India. The government would always goad the various organizations to work only along economically beneficial lines. Most of them buckled under this pressure. George Watt, for example, was asked in 1903 to prepare an abridged volume of his famous *Dictionary of the Economic Products of India*. But he was not given a free hand in selecting the products. He was asked to include only those which were of commercial value. The result was that instead of a Dictionary of Economic Products, he produced a Manual of Commercial Products.

Colonial researchers often found themselves unable to distinguish between 'basic' research and 'applied' research. This was particularly true of the geologist and botanists. Their dilemma was fairly acute. On top of it, though the colonial government would always recognize the importance of science, it would never approve of 'any large outlay upon them which must, however useful in its remote results, be immediately unremunerative'. Some of the specialists (especially the botanists) felt slighted. A few received a great deal of attention while others none; for example, large sums were spent on geological explorations and nothing on the examination of agricultural soils. George Watt wrote to Thiselton-Dyer (15th January, 1902) that its 'absurd to suppose that the Geology of India requires fourteen European experts, while the Agriculture and the Industries of India must be content with two or three expert investigators.'

A significant feature of this phase is the relative neglect of medical and zoological sciences and this is in sharp contrast to larger investments in botanical, geological and geographical surveys from which the British hoped to get direct and substantial economic and military advantages, while medical or zoological sciences did not hold such promises. Western medical classes, for instance, were started in 1822, but it took another thirty years to produce the first exhaustive compilation of information on tropical disease in India. Charles Morehead brought out in 1856 *Clinical Researches on Disease in India* in two volumes. The treatment and study of tropical diseases was undertaken by individuals who were separated both geographically and professionally and so, naturally, a consistent body of knowledge failed to develop. This was true for every branch of knowledge.

Another important feature is the almost total absence of pure or theoretical research. Research activities in science like physics and chemistry which had by then reached 'a professional stage' in Europe, were hardly noticeable in India. In the *Centenary Review of the Asiatic Society* (Calcutta, 1886), P.N. Bose apologetically wrote: 'Our chapter of chemistry at the Asiatic Society is near being as brief as the proverbial chapter on Snakes in Ireland.' Till the advent of P.C. Ray, only one chemical paper had appeared by A. Pedler on the volatility of some of the compounds of mercury. There were chemical analyzers in every province but their job was confined only to medico-legal cases and the inspection of government stores. India was found suitable only for field research. She was in fact used as a 'vast storehouse' with exotic varieties of flora, fauna and minerals which were to flood the European laboratories for many years to come. The real research was thus to be done in the metropolis. India could get only ancillary units. And this happened in a century when England itself was undergoing a phase of transition wherein professional scientists, the government and industrialists who understood the full potentialities of science, were all attempting the very difficult task of integrating science into the English government, industry and education. In India the story was, however, different. Here scientific explorations brought the government, science and economic exploitation into a close relationship. But the Indians and India' s interests were left largely in the cold.

37.5 TECHNOLOGY, EMPIRE AND ECONOMIC GROWTH

Technological changes occur in every society. But the parameters of development are determined by the pace with which technological changes take place in a particular society and its ramifications. In pre-British India, the process was definitely slow. Although not primitive, it certainly was no match to what was then happening in

Europe. A European thinker Max Weber marvelled at how the Indians had perfected the 'technology of contemplation', but faulted them on material technology. Why, it is often asked, did India not generate these modern technologies, and why was it sometimes slow in their absorption? It is easier to ask such questions than to answer them. Did British colonisation accelerate India's 'fall'? Or did the British presence, however inadvertently and lacking in foresight, prepare what became in Indian hands a vital basis for later economic, scientific, and technological take off? If so, how was this managed, and what conclusions may be drawn? Such questions call for an emphasis on structural and technological factors, to take their place alongside the political, administrative and cultural literature.

Civilian officials were concerned about traditions and customs and did not wish to unsettle them for fear of a revolt. But technical men like engineers were not enamoured by such considerations. They were less interested in 'local knowledge and practices'. Their technical discourse was universal. Thorough professionals which they were, their real concern was to ensure the most efficient use of nature in the service of the state. Among the new technologies of the Victorian era which made waves in India were the steamship, exotic seeds, the telegraph, and of course, the railway. In the industrial sector, in order to maintain commercial advantage, British legislation largely discouraged technological change in India. Failure, it seems, can be attributed either to colonialism, the retention of an archaic culture, the changing nature of the technological push, or to some combination of these factors. Whether it be the railways or any other technology project the disadvantages accruing from the loss of sovereignty are well manifest in their internal workings. They remained enclavists. Technology transfer is a deliberate (perhaps organic) deliverance. What colonial India saw was a cultural as well as an economic syndrome which contained within itself an intricate interplay of 'colonial' penetration, 'native' resistance and response. Caste did not act as a barrier. Yet colonialism and the 'technological imperatives of the nineteenth century' collaborated to ensure India's relative technological backwardness.

In short, India's burgeoning commercialisation was not supplemented or followed by industrialisation. Formalised courses were there, but no incentive to innovation. A factory system did emerge, but industrial laboratory came only on the eve of independence. For India to industrialise, using applied science, there had to be structural incentives to invest and innovate. But these could not come from 'within', as the 'within' had lost its sovereignty. The nascent Indian bourgeoisie could not produce heavy capital goods on a weak and dependent technological base. They faced formidable problems arising from the absence of essential machinery, know-how, and trained personnel. The 'token' industrialisation that did take place in certain sectors (textiles and later in steel) had no 'multiplier' effect on the industrialisation of the colonial economy as a whole.

37.6 WHY SCIENCE EDUCATION?

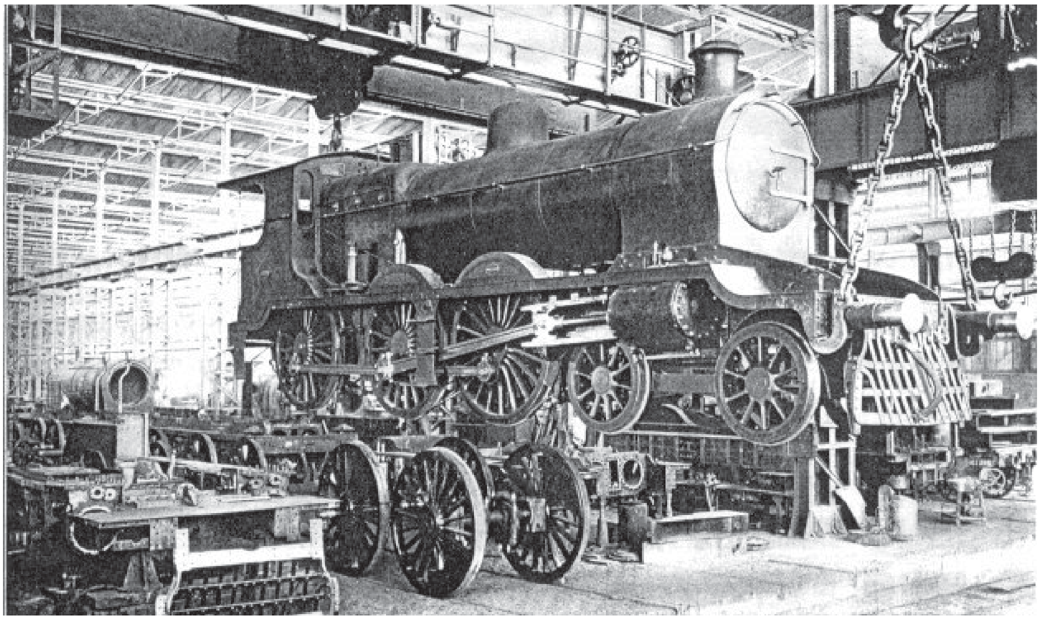
In the educational scheme, science was never given a high priority. The character of 1813 called for the introduction and promotion of knowledge of the science among the inhabitants of British India. But it remained a pious wish. Moreover, it gave no indication of which system of science, indigenous or European, was to be preferred. In 1835, Thomas Babington Macaulay not only succeeded in making a foreign language (English) the medium of instruction, his personal distaste for science led to a curriculum which was purely literary. The entry of science was thus delayed. A few medical and engineering colleges were opened but they were meant largely to supply assistant surgeons, hospital-assistants, overseers, etc. The curriculum, the instruments, and the very organisation of these colleges were geared to meet the requirements of only subordinate services. Later in 1870, the Indian universities began to show some inclination towards science education. In 1875, the Madras University decided to examine its matriculation candidates in geography and elementary physics in place of British History. Bombay was the first to grant degrees in science, Calcutta University divided its B.A. into two branches -' A' course (i.e. literary), 'B' course (i.e. science).

Even this slow growth of science education was beset with many problems. First was the very, aim and character of educational policy itself i.e. 'character formation'. K.M.Chatfield, Principal of Elphinstone College, admitted that the institution of university professorship would indeed foster the development of knowledge through research but argued that not this but 'the education of youth was the aim of the system'. For this purpose a liberal-literary education was found more suitable. The second problem was the shortage of funds and its unequal distribution. In 1900 the four colleges of Patna, Cuttack, Hooghly, and Krishnagar cost the government Rs.55,441 while the Presidency College of Calcutta claimed Rs.l,14,702. Another problem was that the authorities in India looked for western models. C.Benson of Saidapet Agricultural College, for example, justified major emphasis on theoretical instruction there on the ground that Professor Jorgensen had done the same thing for the Royal Agriculture College at Copenhegen. But they seldom incorporated their advantages, and in the name of adapting to the local conditions often made a mess of them. In almost every field of activity, British institutions were looked upon as the ideal models. But they would not grant anything like "higher form of scientific or technical education". What India got was some sort of a hybrid emerging out of a careless fusion between industrial and technical education. What is more, the adoption of English as the sole medium of instruction in science rather hampered its percolation to the lower classes.

The British educational experiments in India have often been severely criticized. Education was no doubt an important segment of the whole colonial enterprise and was definitely meant. to strengthen it. Gauri Viswanathan (New York, 1989) calls it a 'mask of conquest'i and Susanta Goonatilake (New Delhi, 1982) considers it a tool for 'cultural blanketing'. Are these sweeping judgements? S.Ambirajan (Deepak Kumar, 1995) raises the important question as to whether the system was planned and erected for just this aim or whether there were other forces that brought about the same results. He believes that chance, more than foresight, determined the future. There is also a bureaucratic momentum, which propels institutions along a path, though not necessarily the one charted by the initiators. 'Chance' and 'bureaucratic momentum' are valid arguments if we do not lose sight of the fact that it was a colonial bureaucracy. This bureaucracy ensured the primacy of colonial requirements. Engineering colleges existed for the Public Works Department and were called 'civil' engineering colleges. The nature and pattern of engineering education in India differed from that of Britain. Whereas in England it evolved from below and gradually became a part of the University curriculum, in India it was organized from above. Though in France also it was organized from above, the motive and situation differed greatly. In Europe, engineering education was developed in order to facilitate the process of industrialization. In India there was no such imperative. Here hopes were pinned not on 'material 'but on 'moral' uplift. In fact, the whole aim of colonial education was 'moral development 'and' character formation'. The 'native' character was considered defective, immoral and superstitious. The 'new' education armed with western rationality was supposed to correct it. But the Public Works Department (PWD)-oriented education could not have achieved this.

37.7 TECHNOLOGICAL RAMIFICATIONS

The latter half of the nineteenth century was a period of consolidation and institution building. These institutions not only ‘imported ‘knowledge; they imparted and, to some extent, generated knowledge. But could they diffuse new knowledge and to what extent? Telegraphs and railways were the high-technology areas in those days. Telegraph operations remained a purely governmental exercise, while the railways, raised on guaranteed profits, depended on wholesale import from Britain. Even the repair-cum-manufacturing establishments, like the Jamalpur workshop (established in the year 1862), proved to be islands in themselves. No technological spin-off could emerge, much less galvanize, the neighbourhood of a railway colony. Mechanical engineering came later and remained a poor dismal cousin of engineering in the public works department.



Jamalpur workshop

Irrigation and later hydraulic engineering definitely benefitted from the large irrigation works. The Roorkee Engineering College was closely linked to Proby Tomas Cautley’s Ganges canal. Whether the generation or refinement of irrigation technology at Roorkee or Guindy (in Chennai?) reduced or increased the economic dependency or India is arguable and a matter of several statistical debates. These enterprises were basically technology projects with specific aims, and not technology systems with a wider canvas and greater results. A geographical relocation of technology (as in the case of railways) was possible and was achieved, but a cultural diffusion of technology is so different and much more complex. Moreover, the professional colleges were so controlled that they could not induce change at perceptible or a faster pace. The medium of instruction was also a factor to be considered. In Japan, the Japanese had insisted on their own language as a medium of instruction. The result was that modern knowledge and the scientific spirit could percolate down to the masses. In India, colonial education widened the gulf and accentuated the age-old divide. Even in government institutions, growth was kept under a self-regulatory check. The Tokyo Engineering College was established in 1873, much later than the Engineering College at Roorkee, and by 1903 it had a staff of 24 professors, 24 assistant professors and 22 lecturers. The Massachusetts Institute of Technology was established in 1865 and by 1906 it had 306 teachers. On the other hand, Roorkee, even after hundred years of existence (i.e. in 1947), had only 3 professors, 6 assistant professors and 12 lecturers. The inference is simple. As D. R. Headrick points out, colonial rulers educated their subjects only up to a point. Beyond that point, they withheld the culture of technology.

37.8 INDIAN RESPONSE

Indian response can best be understood in terms of a cultural encounter that was initially disturbing, even agonizing. Gradually the colonizer-colonized relationship stabilized and the recipients started examining what was living and what was dead in their system, and, under the new circumstances, what to accept and what not. The encounter raised questions of attitude (towards each other), an uneasy acceptance, a quest for identity and, finally, the seeds of decolonization.

There was definitely an urge to comprehend the modern knowledge and tools that the colonizers had brought, and to assimilate them. This urge came from within, and the acculturative influence of European thought and Christian liberalism strengthened it. Even the commercial class realized the importance of new knowledge. Leading Bombay merchants like Manekji Curserjee and Jagannath Sunkersett viewed Western arts and sciences as a commodity, easily transported and, when acquired, easily adopted for use like any other material goods. The new interlocutors did put a premium on alien rule, and in a sense idolized it and supported downward filtration. They had to do this the more so because initially they could think of no other effective way to dealing with the serious ills of their society. They experienced a dual alienation (a la Cabral) from the traditional and later from the colonial life and system. (Panikkar, 1986) To some extent they could anticipate the distortions the colonial medium was likely to produce. But the realization was slow and diffident. Perhaps this explains why Rommohun Roy (1772-1833, Calcutta) looked to both Vedanta and the West. Ishwarchand Vidyasagar (1820-91, Calcutta), an admirer of Western knowledge, wanted Indian students to study their own 'false system' also. Bal Shastri Jambhekar (1802-46, Bombay) commenced his science popularization activities in both Marathi and English. and Master Remchandra (1921-80, Delhi) began his mathematical Treatise from a twelfth-century Indian text, Bhaskar's Bij-Ganita. The soil was being prepared for cross-fertilization, and the seed was a crossbreed.

Rommohun Roy and Vidyasagar were great social reformers. Unlike them, Bal Shastri Jambhekar and Master Ramchandra concentrated in mathematics teaching and science popularization. Jambhekar was the first Indian to become a professor of mathematics and astronomy. He taught at Elphinstone College, Bombay, and among his early pupils was Dadabhai Naoroji, the doyen of Indian nationalism. Jhambhekar worked for science learning through the local Marathi language. In 1836 he published the Marathi translation of a well known English work on Mathematical Geography, to which he added an 'Essay on the system of Bhaskarcharya'. In 1942 he published in Marathi two books, *The Theory of Equations* and *The Differential and Integral Calculus*. A little later in Delhi, Master Ramachandra tried to revive the Indian spirit of algebra so as to resuscitate 'the native disposition'. Bhasker was common to both. To begin with one's own heritage was quite natural. Indeed, this was the strategy advocated by the orientalists' as well. L. Wilkinson a British Resident and an astronomer at the court of Rewa, found Bhaskara's works 'beyond all comparison, the best means of promoting the cause of education, civilization, and truth amongst our Hindu subjects. What can be more flattering to the vanity of the Hindu nation, than to see their own great and revered masters quoted by us with respect, to prove and illustrate the truths we propound', L. Wilkinson, 'On the use of the Sidhantas in the work of native education', *Journal of the Asiatic Society of Bengal*, 1834, vol. 3, 504-19. Ramchandra, however, moved ahead and incorporated the post Bhaskara 'advances' in his Treatise on the *Problems of Maxima and Minima*, published in 1850. His idea was to bridge the gap. But the efforts aborted. An alien government confidant of its epistemic superiority (especially after Macaulay), would not allow the transplantation of modern science on an indigenous base.

Another interesting dimension of these 'early stirrings' was that both Jambhekar and Ramchandra took to science popularization through the Indian languages. Both worked for their respective Native Education Society and published journals (*The Bombay Durpan* in English and Marathi, and *Mohabb-e Hind* in Urdu). Both were avid translation enthusiasts. In a meeting organized by the Delhi Education Society on 'Learning European Knowledge through Translations' on 12 November 1867, an English priest argued that no society had gained knowledge through translations, to which Ramachanra replied that Europe was enriched through translations as the centres of science had shifted from Greeks to Muslims.

What Ramchandra probably did not realize then was that the translations in the Arab and the Mediterranean culture area were accompanied and often preceded by original research. The subsequent years were to prove the priest more correct, as the translation activities of Master Ramchandra and his more illustrious contemporary Sir Syed Ahmad Khan (and the Aligarh Scientific Society) were to end on a feeble note.

The most important characteristic of mid-nineteenth century Indian thinking was an unprecedented emphasis on cultural synthesis. Akshay Kumar Dutt, a contemporary crusader, worked for 'Indianising Western Science', Numerous journals of the period (like *Samvad Prabhakara*, *Tatva Bodhini* and *Vividharta Samgraha*) claimed the same objective. The idea of a cultural synthesis gave them the best of both worlds. First it enabled them to absorb culture shock and also promised a possible opportunity to transcend the barriers imposed by colonialism. Moreover, it also fitted well with the dominant Hindu doctrine of epistemological pluralism. So the clamour for cultural synthesis grew. Sir Francis Bacon (1561-1626) and Auguste Comte (1798-1857) impressed the Indian mind. But how to integrate their experimental method and rationality into the Hindu "science of spirit." This, the local thinkers were not clear about. They pursued a great variety of strategies – imitation, translation, assimilation, 'distanced' appreciation, and even retreat to isolation – but without much success. The search for synthesis remained, elusive, yet it did accelerate the quest for identity.

During 1860-80 a number of cultural essayists tried to articulate modern scientific rationality in terms of indigenous traditions and requirements. Bankimchandra, a Bengali novelist of high intellect and repute, for instance, wrote on *Vijnan Rahasya* (Secrets of Science), which appeared in *Banga Darshan* during 1865-70. With the help of John Tyndall's *Dust and Disease* he wrote *Dhula*, and T.H. Huxley's *Lay Sermons* was utilized in *Jaivonik*. Bhartendu Harishchandra, a very influential Hindi laureate, was also impressed by the developments in machinery and he associated them with a certain kind of attitude and behaviour. There are a number of direct reference to Comte in his literary as well as discursive writings (for example *Debi Chaudhurani* and *Dharmatatva*). These forays sometimes led Bankimchandra to return to certain ancient theological concepts. In 1873 he rejected the Hindu concept of Trinity as an aberration, but in 1875 he found it close to Darwin's theory of natural selection. Hindu spiritualism finally sucked up many who ventured to travel outside its orbit. Islamic progressives faced a similar situation and sometimes fared worse. In 1877 one Maulvi Ubaidullah wrote:

> The Mahomedans with their philosophy are exactly in the position of the school men of Europe, that is they have travelled half way towards actual civilization: consequently when the modern reformed philosophy of Europe once gains an entrance to their minds, they will be able to make more rapid progress than their neighbour Hindoos. Among us a Newtonized Advicenna or a Copernicized Averroes may spring up, who may be able to criticise even sons of Sina and Rushd.

The lure of inching towards' actual civilization' and the hope of producing' a Newtonized Avicenna (Ibn Sina, 981-1037) or a Copernicized Averroes' (Ibn Rashid, 1126-1198) present a curious mix of both self- criticism and a yearning for change (and also a hope perhaps yet to be realized).

Two things are striking in any account of this period. First, it was an age of translations. The numerous schoolbook societies and the scientific societies (Aligarh and Bihar, for example) were basically translation societies. Translations, no doubt, were very important and must have helped popularize certain scientific notions. But a major lacuna was that they were not accompanied, except in one or two cases, by any research. They remained mere translations, secondary, superficial and of limited value. In earlier transfers of knowledge, for example from Greek to Arabic, research 'preceded' or at least accompanied translations. This was not so with 'colonial transfers' at least in the case of India. It was at best a 'trial' transfer and in this sense one could speak of the disintegration, not of the integration of knowledge. Yet the penchant for translations must have done some good. Following Ballantyne's (1825-1894) efforts, Rajendralal Mitra (the most active Indian number of the Asiatic Society) prepared 'a scheme for rendering European scientific terms in the vernacular'. In the vernaculars of India 'untrammelled by any existing scientific literature' he could see the possibility 'to secure something thoroughly national and perfect.' With limited and defective means his intentions, however sound, were to remain utopian.

The second important aspect, of course, is the magnetic pull of tradition. In a subtle way the colonizers themselves promoted this by heaping occasional praises on 'the spirit of the East', and 'the Hindu Technology of Contemplation', etc. The Indians were shown as a superior civilization in spiritual matters. This was some, though poor, compensation for the loss of sovereignty. Indians themselves seemed to enjoy this distinction and it seems that Max Muller (German Indologist) was discussed more than Charles Darwin. The positivists and the Brahmos emphasized the importance of reason and observation, though their reason was not without God and was mixed with a heavy dose of moral and spiritual teaching. In any case, modern science was not seen as an alien import. Darwinism, for instance, was imported readily and the theological issues at its heart did not cause a ripple in India. The new paradigms in science were quickly accepted and numerous popular articles traced the seeds of modern advancement in ancient texts. How to characterize such arguments? Were they exercises in revivalism or revitalization of cultural self-defence or self-assertion? It was perhaps a combination of both a delicate balancing act which promised a semblance of identity in an age of intellectual torpor and crisis.

The theme of the identity of the colonized on its own terms (that is, away from what the colonizers thought about or dictated) also contained the seeds of decolonization.

An imperial rationalist discourse showed Indians how rationalism could be turned against the Europeans themselves. Rationalism was seen as something inherent in human nature rather than a European 'speciality' and as a mark of progress independent from Europeanization. Gradually colonialism came to be viewed as a cultural invasion of space, to be ended, neutralized and rolled back.

37.9 FROM DEPENDENCE TO INDEPENDENCE

One of the first to realize the necessity of re-articulating science in national terms was Mahendra Lal Sircar (1833-1904). In 1869 he wrote an article 'On the desirability of a national Institution for the cultivation of sciences by the natives of India'. This title is extremely significant. He argued against the prevailing contention that the Hindu mind was metaphysical, and called for the cultivation of the sciences by 'original' research. He wrote, 'We want an Institution which will combine the character, the scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science', and then added, 'I want freedom for this Institution. I want it to be entirely under our own management and control. I want it to be solely native and purely national'. In Apri1, 1875, *Bharatvarshiya Vigyan Sabha* (an all-India Science Society) was formed. Its objects were: (1) to discuss science as a subject by instituting a Society at Calcutta, which would have branches in other parts of India; and (2) to educate the people of India in various scientific subjects and to publish all the ancient Indian tracts relating to science. In 1876, after a great deal of effort and controversy, the Indian Association for Cultivation of Science was inaugurated in Calcutta. This event was no less important than the establishment, nine years later, of the Indian National Congress, a political forum that was to spearhead the national movement. The Association was a cultural challenge and symbolized the determination of a hurt psyche to assert and stand on its own in an area that formed the kernel of Western superiority.

The Swadeshi movement provided further impetus. It had two objects: (1) the promotion of education along national lines and under national control with special reference to the exact sciences and technology; (2) the industrialization of the country and the advancement of materialism. In 1904, al1 Association for the Advancement of Scientific and Industrial Education of Indians was formed. The object was to send qualified students to Europe, America and Japan for studying science-based industries.

As noted earlier, the environment was not conducive to higher studies, much less research. The Indians were allowed only subordinate posts and even those who had distinguished themselves abroad were given less salary than the Europeans of the same grade and rank. This "apartheid" in science made the Indians react strongly. J.C. Bose refused to accept this reduced salary for 3 years. Not only this, till the Royal Society recognised Bose, the College authorities refused him any research facility and considered his work as purely private. J.C.Bose was unorthodox in other ways. He was one of the first among modern scientists to take to interdisciplinary research. He started as a physicist but his interest in electrical responses took him to plant physiology. To fight for a place in the metropolitan scientific circle was not less difficult than fighting against the administrative absurdities of a colonial government. Bose persisted and won. P.C. Ray had also suffered. On his return from England in 1888 with a doctorate in Chemistry, he had to hang around for a year and was finally offered a temporary assistant professorship. All through he had to remain in Provisional Service. P.N .Bose preferred to resign when in 1903 he was superseded by T. Holland, who was 10 years junior to him, for the directorship of the Geological Survey.

These problems were reflected also on the political platform of the country. In its very third session (1887), the Indian National Congress took up the question of technical education and since then every year repeatedly passed resolution on it. K.T. Telang and B.N. Seal pointed out how in the name of technical education the government was imparting merely lower forms of practical training. The Indian Medical Service was severely criticised. In 1893 it passed a resolution asking the government 'to raise a scientific medical profession in India to the best talent available and indigenous talent in particular. Whether it be education, agriculture or mining, the Congress touched several problems under its wide sweep.

The activities of this era had two important features. One was that almost all the exponents of Swadeshi looked to Japan as a major source of inspiration. Japan's emergence as a viable industrial power and its subsequent military victory over Russia in 1904-5 caught the imagination of a fellow Asiatic, though enslaved, society. Another characteristic was that sometimes they showed revialist tendencies. Distant past comes in handy for the recovery of a lost self or reassertion of one's identity. This search for moorings made P.N. Bose (a geologist) write *A History of Hindu Civilization* in 3 volumes. J.C.Bose gave Sanskrit names to the instruments he had fabricated *(Kunchangarph, Soshungraph)*. Many science popularisers had a tendency to show that whatever was good in western science existed in ancient India also. For example, Remendrasundar Trivedi's discussion on Darwin ended with Gita. In his posthumous publication *Vichitra Jagat* (published in 1920) Trivedi talks of two worlds, one *Vyavharik Jagat* (visible world), the other *Pratibhasik Jagat* (reflected according to the individual consciousness). The first world he relegates to the collective and demonstrable outcome of direct experience while the other he extols. Then he talks about one more world that of concept *(Dharna)* which can never be observed or measured. Later B.K.Sarkar wrote on the Hindu Achievements in Exact Science. They were all for the industrial application of modern science but would not like to trespass certain cultural limits. They tried to demonstrate that the Indian ethos and the values of modern science were congruent and not poles apart. This was an extremely difficult task. Total colonisation had certainly blunted the possibility of evolving perspectives rooted in indigenous intellectual and cultural heritage.

These efforts had nonetheless a galvanizing effect. Taking advantage of the University Act of 1904 which allowed the existing Indian universities to organise teaching and research instead of being merely affiliated teaching bodies, Sir Asutosh Mukherjee took the initiative in establishing a University College of Science in Calcutta. Eminent Scientists such as P.C.Ray, C.V.Raman, S.N.Bose and K.S.Krishnan taught there. This very college, although starved financially all through, produced a group of physicists and chemists who received international recognition. By contrast, many government scientific organizations staffed by highly paid Europeans cut a sorry figure.

Those who put India on the scientific map of the world were J.C.Bose who studied the molecular phenomenon produced by electricity on living and non-living substances; Ramanujan, an intuitive mathematical genius; P.C.Ray who analysed a number of rare Indian minerals to discover in them some of the missing elements in Mendeleef's Periodic Table. C.V.Raman's research on the scattering of light later won him the Nobel prize in 1930. K.S.Krishnan did theoretical work on the electric resistance of metals. Meghnad Saha contributed to the field of astrophysics, S.N.Bose's collaboration with Einstein led to what is known as the Bose-Einstein Equation; D.N. Wadia worked in the field of geology, Birbal Sahni in palaeobotany, P.C.Mahalanobis in Statistics, and S.S.Bhatnagar in Chemistry. Apart from the individual contributions of these scientists, their greatest contribution was in the field of teaching and guiding research. Many of them set up scientific institute, for example the Bose Institute (1917), National Institute of Science (1934), Indian Academy of Science (1934), Sheila Dar Institute of Soil Science (1963), Birbal Sahni Institute of Palaeobotany, etc. This gave further impetus to scientific activity in India.

Soon the need for an annual scientific meeting was felt so that different scientific workers throughout the country might be brought into touch with one another more closely than in the purely official and irregular conferences such as the Sanitary Conference or the Agricultural Conference. Thus was born the Indian Science Congress in 1914 with objectives similar to those of the British Association for the Advancement of Science.

In the wake of the first world war the Government realised that India must become more self-reliant scientifically and industrially. The Government appointed an Indian Industrial Commission in 1916 to examine steps that might be taken to lessen India's scientific and industrial dependence on Britain. The scope of the resulting recommendations was broad, covering many aspects of industrial development. But few of the Commission's recommendations were actually implemented. Similar was the fate of the recommendations of numerous other Conferences and Committees. Whenever requests were made by Indians for starting new institutions or expanding existing ones, the government pleaded insufficiency of funds or inadequacy of demand. The interests of the colonial administration and those of the nationalists in most instances simply clashed.

A glance at the development during the first quarter of 20th century will indicate that this period was characterised by a conflict something like small vs. big, traditional vs. modern. When M.K.Gandhi started his campaign for cottage industries, varying notes were heard at the annual sessions of the Indian Science Congress. P.C. Ray, for example, held that general progress through elementary education and traditional industries was a necessary precondition for scientific progress. But many differed with him. M.N. Saha and his Science and culture group opposed the Gandhian method of economic development and supported industrialisation on a large scale. The socialist experiments in Russia had unveiled the immense potentialities of science for man in terms of economic and material progress. The national leadership was veering towards heavy industrialisation and socialism, both of which stood on the foundations of modern science and technology. Saha found his 'Lenin' in Subhas Chandra Bose when the latter became the Congress President in 1938. On Saha's persuasion, Bose agreed to accept national planning and industrialisation as the top item on the Congress agenda. The result was the formation of the National Planning Committee in 1938 under the chairmanship of Jawaharlal Nehru. This Committee appointed 29 sub-committees, many of which dealt with such technical subjects as irrigation, industries, public health, and education. The University sub-committee on technical education worked under the chairmanship of M.N.Saha and had distinguished members such as Birbal Sahni, J.C.Ghosh, J.N.Mukherjee, N.R.Dhar, Nazir Ahmed, S.S.Bhatnagar and A.H.Pandya. The sub-Committee reviewed inter alia, the activities of the existing institutions and sought to find out how far the infrastructure of men and apparatus was sufficient in turning out technical personnel.

The outbreak of the second world war made it essential for the colonial government to work for industrial self-reliance to meet the challenges posed by war conditions. It was, therefore, felt necessary to establish a Central Research Organisation and this was eventually followed by the establishment of the Council of Scientific and

Industrial Research in 1942. As part of the post-war reconstruction plan the government invited A.V. Hill of the Royal Society. In 1944 he prepared a report that identified various problems confronting research in India. These developments offered greater opportunities to Indian scientists in policy-making and management of scientific affairs. In fact the origins of the science policy of free-India and of the whole national reconstruction can be traced in these activities.

37.10 SUMMARY

The foregoing analysis of British India illustrates that it is futile to expect the emergence of science under an alien administration obsessed with one-sided commercial preferences. In such a situation field sciences may be developed through imported scientists as an economic necessity but no fundamental research was possible. A few colonial scientists made important contributions that no doubt enriched science in general, but their activities hardly succeeded in introducing science to the Indian people. Colonial science did, on the whole, help to sustain exploitation and underdevelopment.

To these developments Indian response was not passive. Science course in the universities got good response, and the medical and engineering colleges attracted good students. For a long time Indians were denied access to scientific departments. The rising Indian middle class took up the challenge. Several Institutions were established and numerous popular science tracts and journals were published. Even the so-called conservative farmers were found amenable to change. They had no objection to the new. tools provided these brought profits and were within their means. The problems was not cultural stagnation or social conservatism of the Indians, rather it was finding economically viable appropriate technological solutions and inculcating scientific temper. This search is still on in free India.

37.11 GLOSSARY

Jesuits : The Jesuits belong to the Society of Jesus founded by Ignatius of Loyola and his nine companions in 1540. The history of the Jesuits in India dates back to the time of Saint Francis Xavier, a Spanish Jesuit. Ignatius sent him to Portugal's colonies in South Asia. He arrived in Goa on the west coast of India in 1543.

Manchus : Manchu was originally a tribal group of the Jurchen. The Manchus were able to set up their own dynasty, Jin (1115-1234) by overthrowing Liao dynasty in Manchuria. However, their dynasty was shortlived. Soon they were defeated by Ogetai Khan and became part of Yuan dynasty. In 1616 Manchu leader, Nurhaci (1559-1626) established the Qing (Later Jin) dynasty. Beijing was captured by Li Zicheng in 1644 and the Qing empire moved the capital from Mukden to Beiging.The Qing dynasty lasted till 1911.

Ottomans : The origins of the Ottoman dynasty can be traced back as far as the thirteenth-century. The founder of the dynasty was Osman, leader of a branch of the Qayigh clan that inturn was part of the Turkic Oghuz tribe of Central Asia. The Oghuz was amongst those Turkic groups who had fled west with the Mongol invasions of the thirteenth century and threatened the ailing Byzantine empire. Ottoman ruler Mehmet finally captured Constantinople (Istanbul) and defeated the Byzantine ruler in 1453. With the siege of Vienna (1683) their military power reached its zenith but at the same time their defeat marked the beginning of an irreversible decline.

Safavids

The founder of the Safavid dynasty was Ismail I. In 1502 Ismail was enthroned as shah of Iran. The Safavids established Shi'ite Islam as a state religion of Iran. Their greatest ruler was Shah Abbas I (1588-1629). He made Esfahan as his capital in 1598. After the death of Shah Abbas I (1629) the Safavid dynasty lasted for about a century, but except for interlude during the reign of Shah Abbas II (1642-66) it was a period of decline.

37.12 EXERCISES

1) Critically examine the colonial policy towards science education in India.
2) Analyse the Indian response towards colonial interventions in the field of science and technology
3) Examine the impact of swadeshi movement on the development of science and technology in India.
4) To what extent did colonial policies influence the development of science and technology in India.
5) Analyse the development of scientific knowledge during the British period.

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