The late 1990s saw a surge in the Indian IT industry. To assure potential clients of their permanency, Indian software companies built large, expensive campuses, where they made working conditions as attractive as possible, to help them retain workers. Trees grew and streams flowed inside buildings, and swimming pools, badminton courts, meditation rooms, auditoriums, and restaurants were provided.

The IT boom in the United States was the source of India's software exports. It ended in 2000; the downturn in India was delayed until early 2001. The low-cost Indian programmers' market in the United States expanded. More Indian programmers got an H-1B visa in 2001–2002 than in any previous year. Of the 331,000 H-1B visas issued in the United States that year, 191,000 were issued to software engineers, and 137,000 of those went to Indians. Although export growth slowed down, exports still continued to grow. From an average annual compound rate of 52 percent between 1993–1994 and 2000–2001, export growth fell to 22 percent in the next two years.

However, demand for Indian programmers also fell in 2002. For the first time since body-shopping began in the late 1980s, Indian companies did not face a labor shortage. Body-shopping virtually ceased; and firms that depended on it closed down. So did many small firms, which served local firms.

As realization of low wages in India spread, new services and new companies began to locate in India. Until 2000, most call centers serving the U.S. market were in the United States; the only countries that had offshore call centers were Britain and Ireland. After 2000, both U.S. and Indian firms began to set up call centers in India. Back-office functions, such as record transcription, accounting, and documentation, also began to be moved to India. In 2003–2004, exports of such IT-enabled services were estimated to be $3.6 billion.

Major international IT firms have set up a presence in India, mostly doing work outsourced to them by their head offices. The software industry has grown to a size at which it affects the larger economy, particularly in its major centers in the south: Bangalore, Chennai, Poona, and Hyderabad. The industry's export revenues have added to India's bulging reserves of foreign exchange. As a result, the Indian economy has been flush with liquidity, and interest rates have been halved since the late 1990s.

India's IT development has created a model of placing high international value on India's educated manpower. Some 150 global companies, including General Electric, Oracle, DaimlerChrysler and Hyundai, have set up research and development centers in India. Indian pharmaceutical companies are turning research and development into internationally marketable products, doing research on commission for companies abroad. Indian companies are venturing into bioinformatics. India's hospitals are attracting patients from neighboring countries. The Anglophonic educational system planted decades ago by the British has begun to bear global fruit.

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See also **Indian Institutes of Technology (IITs); Industrial Growth and Diversification; Intellectual Property Rights**

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INFRASTRUCTURE AND TRANSPORTATION, 1857–1947 At independence in 1947, the most tangible legacy of British rule in India was the modern infrastructure that the regime had left behind, built to a large extent with British expertise. This legacy included the railways, ports, major irrigation systems, telegraph, sanitation and medical care, universities, postal system, courts of law, information-gathering systems, and scientific research. The immediate motivation behind infrastructure development by the British was governance rather than development or welfare. And yet, once built, such assets did not necessarily serve only imperial

interests, but were available as public goods. That said, the absence of a strong welfare or developmental objective imposed unevenness in the way that these assets were created.

The Impetus

In the nineteenth century the main focus of productive investment by the state was irrigation, railways, roads, and the telegraph. Defense interests played a role in the creation of modern communication and transportation networks, but they were not the only factor. Business interests too urged that such systems be set up in India. The influence of Lancashire textile-mill owners behind the construction of a railway in India is an example. Because Britain was a pioneer in these new technologies, the knowledge and capital were more cheaply available to India than to many other developing countries of that time. Famines in the nineteenth century exposed the susceptibility of the economy to shocks, and underscored the importance of irrigation in preventing famines, railways in distributing food, and public works for providing wage work to affected people.

By the interwar period, the drive to create physical infrastructure had spent itself. On the other hand, the demand for welfare expenditure had been gaining ground. The demand for education was connected with movements for social reform. Mass education had thus far been neglected by both public and private institutions. Extreme illiteracy and mortality in India showed rather starkly that fifty years as a British colony had done little to enable India to approach British standards of social development. Yet, given the government's own poverty and political commitments, the change in mindset made rather little impact on the scale and composition of government investment.

Public investment in railways was regionally well balanced in the long run, but investment in irrigation, roads, and power was unevenly distributed. There was apparently a correlation between the initial inaccessibility of a region, its size, and the share of the region in public investment. Burma (present-day Myanmar), for example, was a major recipient of funds. Within British India, western and southern India received more investment than did eastern and northern India.

Irrigation

When the British East India Company took control of the upper Gangetic Plains, an extensive network of irrigation channels in a state of disrepair was found in the western part of the river Yamuna, attributed to Firoz Shah Tughluq. The "grand anicut" (dam) on the Cauvery, attributed to the Chola rulers, was another large pre-British system. The company administration by and large appreciated the importance of these systems, and restored some of them. From the late nineteenth century, major new constructions consisted of canals taken out of perennial rivers (in Punjab, Sind, and United Provinces), and weirs constructed on major rivers (South India). The Punjab canals spread access to water over formerly water-scarce territories. In the South, canals mainly redistributed monsoon water. The most dramatic effect of the former type of canals was the "colonization" of vast areas of wastes and pastures by migrant cultivators. In Punjab these "canal colonies" arose between 1890 and 1930. The colonists did not come from peasant stock necessarily; many were soldiers of disbanded armies, and many others were former pastoralists. A network of canals thus restructured entirely the rural society and politics in some areas of Punjab.

Acreage irrigated as percentage of cropped area increased from possibly 5 or 6 percent in the early nineteenth century to 22 percent in 1938, about 60 percent of the addition to irrigated areas being served by government canals. Among the largest projects undertaken in British India were Upper and Lower Ganga canals (1854–1878; 3,212,000 acres, or 1.3 million hectares), Sirhind canal (1887; 2,471,000 acres, or 1 million hectares), Cauvery delta system (1889; 1,050,000 acres, or 425,000 hectares), the Western Yamuna canal system (1982; 1,236,000 acres, or 500,000 hectares), the Krishna and Godavari delta systems (1898–1890), together serving about 2,471,000 acres, or close to a million hectares, and Sarda canal (1926; 1,236,000 acres, or 500,000 hectares). Smaller works that had considerable impact in a relatively small area included the Sone canal (1879), the Nira valley system (1938), the Mettur project (1934), and the Upper Bari Doab canal (1879).

In the regime of the company, canal construction was left to the engineering department of the army. From 1854, the Public Works Department became responsible for canal construction. A broad distinction was made between those works that were built for administrative or famine relief purposes ("protective" works) and those built to increase agricultural production ("productive" works). The former class was not expected to yield an income, though they might save the government money that would have to be spent on famine relief if a famine occurred. The latter class could be commercially profitable for the government. The water that raised incomes was charged at a certain rate, paid out of that income. This tax accrued to the Public Works Department, and was calculated in the rate of return on capital invested in irrigation projects. Increased income from a plot of land also increased the rental value of that land. In areas outside the Permanent Settlement, the government could realize

Bhakra Dam. When Nehru dedicated the Bhakra Dam (shown here) in 1963, he referred to it as a "temple of modern India," a symbol of the aspirations of developing countries worldwide. In the early twenty-first century, similar large-scale dam projects in India (at last count more than 23) are the focal point of several well-funded campaigns to protect the millions of ordinary citizens displaced by them. SUJATA KULSHRESHTHA / FOTOMEDIA.

this value. But these benefit-cost estimates were neither quite accurate nor persuasive to the critics, in London, of government investment in India.

In 1878 an influential committee of the India Office declared that irrigation projects were a failure, both commercially and in preventing famines. At the same time, the 1880s Famine Commission claimed that irrigation projects were on average profitable for the government. The difference partly reflected official mindsets in India and Britain. This question of what monetary return the irrigation programs generated for the government remained shrouded in speculation. Nevertheless, private enterprise was never seen as a viable alternative in canals. It was felt that allowing the private sector to construct canals would complicate the question of property rights in canal water.

The private gains from irrigation projects were mixed. Did irrigation projects reduce famines and increase peasant incomes? Canal-irrigated area as a percentage of cropped area was not very different between Madras and Punjab in 1900. Yet, Madras suffered far more from famines. The reason was that canals as such could not prevent water scarcity in the dry months if the region suffered from a general shortage of rains. In other words, the natural supply of water and the capacity of canals to prevent famines were correlated. In several parts of the canal-served agrarian countryside, there were dramatic improvements in the wealth and income of the people. But the negative externalities of extensive canal projects were also large. These costs occurred due to a persistent engineering defect, the poor drainage of excess water, and the resulting malaria epidemics and saline deposits. The net effects of canal irrigation were seemingly larger in the initially more water-scarce Punjab and Sind than in a region like western United Provinces, where canals were an alternative to well irrigation. Uniformly, however, canals intensified rural inequality.

Railways

Until the mid-nineteenth century, the common systems of long-distance transportation of cargo were pack animals and small sailing vessels on navigable rivers. Large trains of pack animals were driven by the nomadic Banjaras on

Railway Train Car. With their construction initiated under British rule, India's railways—still one of the largest transportation networks in the world—provided much needed stimulus to the labor market. AKHIL BAKSHI / FOTOMEDIA.

roads that connected western India with eastern and northern India. For short-distance trade and travel, the common means of transportation were palanquins, small river craft, and bullock carts. The older systems of long-distance trade used a lot of labor and time. The railways destroyed them without much resistance. Comparatively lesser attention was paid by the government to roads and short-distance travel, so in that sphere, traditional means of transportation survived until well after 1947.

In 1849 the Government of India entered an agreement with some British railway companies to construct railways in India on a guaranteed minimum return of 5 percent on paid-up capital. The guarantee was meant to attract investment in a venture that would normally be seen as risky because it consumed so much capital for an uncertain return. The guaranteed profit imposed a fiscal burden on the state. But since many crucial lines in India (nearly all those in South India, for example) ran at a loss for many decades after their construction, it is probable that without the guarantee these would not have been built at all.

Railway construction began on a large scale in the 1850s and continued, almost exclusively by the private sector, until 1870. At 1870, Calcutta, Bombay, Madras, and Delhi had become interconnected by the "broad-gauge" system. Thereafter, the fiscal burden became too heavy to bear due to the depreciation of the rupee and the rise in interest rates on government borrowing abroad to pay for guarantees. Increasingly, therefore, the government itself entered railway construction. The first major "meter-gauge" lines were a product of direct investment. Later in the nineteenth century, the government started buying out some of the "guaranteed companies." During the 1920s, all railways in India were brought under government management.

By then the Indian railway system was one of the largest networks in the world. Between 1860 and 1940, total route miles increased from 838 to 41,852. Route miles per 1,000 square miles increased from 0.5 to 26, and route miles per million persons increased from 3 to 107. Passengers carried by the railways increased from 48 million in 1880 to 604 million in 1940. Clearly, the railways had revolutionized the mobility of people and goods in South Asia.

The economic effects of the railways can be classified into two types. First, the railways had significant forward

Truck Owned by Tata Industries. Road construction was a low-priority area of government investment during the colonial period and beyond. In 2004, however, the National Highways Development Project devised an ambitious plan to repair and convert some 8,000 miles (13,000 km) of road in India to four- and six-lane superhighways. AKHIL BAKSHI / FOTOMEDIA.

and backward linkages with other sectors of the economy. Second, there was great reduction in average transportation costs measured in money and time. Railway construction worldwide stimulated the engineering industry, financial markets, and labor markets. In India the first of these three effects was relatively weak until World War I. Until then, nearly all of the railway material was imported from Britain. The government had built railway workshops in India for repair and production of parts, but they were not intensively used. Coal mining was the only important example of backward linkage of the railways. After the war, a progressive "Indianization" began to occur. The role of the railways as a major source of demand for the basic metal industries in India became significant from that time forward. The financial development effect was weaker still, since the major part of the capital came from London. The effect on stimulating the labor market was of great importance. At 1947 the Indian railways were the single largest employer in the organized sector, a distinction maintained today. And railways facilitated the major channels of internal labor migration. A Chota Nagpur laborer, traveling to the Assam tea plantations for work in the mid-nineteenth century, was awestruck by the railway carriage and composed songs, at least one of which compared the black locomotive to the image of Krishna, the dark-skinned god.

Import and export trades in real terms increased enormously as a result of reduction in transportation costs. Because these costs became a smaller part of the price, the supply of goods now responded to narrower differences between local and world price than before. Exports of raw cotton and hides and skins quickly expanded. Railways also facilitated the integration of markets. This is evident from declining regional variability in prices of food grains. Some Indian nationalists alleged that by thus increasing the supply response to the world market, the railways intensified local shortages of food during the late-nineteenth-century famines. More recent research, on the other hand, has attributed the remarkable reduction in the incidence of famine after 1900 to easier interregional crop movements that the railways had made possible.

Roads and Inland Waterways

A systematic history of roads and road transportation in India remains to be written. From the little research that is available on the nature of long-distance trade before the British came to India, it is fair to conclude that

good and safe roads were scarce in pre-colonial and early colonial India. The poor condition of the roads partly reflected limited engineering capability in bridging the numerous rivers. The East India Company restored and constructed some major roads for military purposes, but regular allocation of funds for roads did not begin until the 1830s.

Even thereafter, roads were a low priority area of government investment. Road length grew at a much slower pace than the railways. In 1931 the length of "metalled" roads per 1,000 persons was as low as 0.4. For a comparison, the ratio was above 1.5 in British Ceylon and Malaya. There were possibly three reasons behind this bias against roads. First, road construction was said to have been too costly in India given the terrain, the rivers, and the high repair costs due to the monsoons. Second, roads brought the government no monetary return, whereas the railways did. Third, the lobbies that pushed the government into investment in modern transportation clearly wanted railways, or cheaper modes of long-distance trade.

In northern and eastern India, and sporadically elsewhere, the major navigable rivers were an important means of transportation of cargo. River traffic was cheaper than roads, and carried larger volumes per head. But the role of rivers in long-distance trade was more or less confined to the Gangetic Plains. This traffic was of great antiquity. It declined in competition with the railways.

Ports

India had a long and rich tradition in mercantile marine and shipbuilding. The advent of the Europeans in the Indian Ocean created competition for the Indians in coastal shipping. However, it also stimulated the business of some of the ancient ports like Masulipatnam or Cambay. The final blow to Indian traditional enterprise in ocean shipping came with the displacement of sailing vessels by steamships in the early to mid-nineteenth century. The major ports that carried the bulk of foreign trade in the colonial period were new sites where railways and modern harbors converged, for example, Bombay, Madras, Calcutta, Karachi, and Rangoon. Each served as an export outlet for the products of a vast hinterland. The two western Indian ports enhanced their trade manifold with the U.S. Civil War (1861–1865) and the opening of the Suez Canal (1869). Thereafter, Calcutta and Bombay also grew to become industrial centers. World War I, while upsetting private business through these ports, emphasized their military importance. Bombay especially saw a modernization drive in the early interwar period.

Posts and Telegraph

The foundations for a government postal system were in place before 1858, but it became a widely used utility only in the late nineteenth century. This expansion was largely driven by the demand for the services of the post office. Migration and money orders had become synonymous. In safety, cost, and wide reach, the postal money order was unprecedented in the history of internal remittance in India. Already in 1849 the East India Company had decided to construct a telegraph system along the railway lines. The telegraph became an urgent necessity on account of the Afghan war and the impending war with Burma. The first line, between Calcutta and Diamond Harbour, opened in 1851 and was used to send shipping news from the coasts to Calcutta. The major lines were completed before 1855. This remarkable speed of construction resulted from both strategic needs and Lord Dalhousie's personal interest in the plan. The telegraph was a private enterprise in England and the United States and a state enterprise in continental Europe. In India it turned out to be a state enterprise for military reasons, despite Dalhousie's general aversion to state monopolies. By 1857 the telegraph had proved itself a critical military tool. Not surprisingly, it symbolized evil for the mutineers. With vengeance, they destroyed telegraph establishments wherever they could (and never used it to their advantage). With this lesson behind itself, the Crown rule saw massive expansion of the telegraph system within the country and between India and Europe. From then onward, the commercial uses of the telegraphs began to overwhelm strategic needs, leading to extremely rapid growth in the use of the system.

Power

Electricity generation in colonial India saw significant private-public coexistence and cooperation. By contrast, in the period after 1947, there was a decisive turn toward state monopoly. The first private firm to produce electricity for Calcutta city was proposed in 1891. In the next ten years, a series of legislation laid down the basic framework of regulation. Electricity was first introduced in 1897 by a small firm in the Darjeeling Municipality utilizing a mountain stream. Two years later, the Calcutta Electricity Supply Undertaking started producing electricity with steam power. Two other large hydroelectric projects came up before World War I: the Sivasamudram on the Cauvery, erected by the Mysore government, and the Khopoli plant of Tata Electric Power. The former supplied power to the Kolar gold mines, and the latter to Bombay city. The report of the Indian Industrial Commission (1918) laid great emphasis on the need for organized exploitation of natural resources, including hydroelectric power. However, efforts in this direction had to wait until the mid-1920s, when the provinces

recovered from the initial trauma of "dyarchy" and pursued some of their now exclusive duties, electricity generation for example. In the interwar period a large number of hydroelectric and thermal power units were started, many of these in the territories of the princely states. At 1947 the installed capacity stood at 1.7 million kilowatts.

The process of infrastructure development had inherent inequalities. Irrigation systems remained primitive and undeveloped in large parts, the railways de-prioritized roads, electricity generation was initially drawn toward centers of modern enterprise, and so on. Some of these inequalities were redressed in the post-colonial period, but others continued. Communication and local transportation remain even now of sharply variable quality. The regions poorly endowed have seen a long history of neglect and government failure.

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See also **Economic Policy and Change, 1800–1947; Fiscal System and Policy from 1858 to 1947**

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INFRASTRUCTURE DEVELOPMENT AND GOVERNMENT POLICY SINCE 1950

India's infrastructure services are slowly but steadily moving away from the realm of government control to that of the private sector. Across sectors ranging from telecommunications and roads to power and ports, state-owned agencies are giving way to private sector entities operating in a competitive environment and subjected to economic regulation where necessary. Governments at both central and state levels are actively engaged in managing this transition, devising appropriate policy frameworks and establishing suitable institutions such as the central road fund and independent regulatory authorities in power and telecommunication sectors.

Telecommunications

Since India's independence, its telecommunications sector has continued to be governed by the Indian Telegraph Act of 1885, which placed all telecommunications within the government domain. Telecommunications services were the exclusive monopoly of the Department of Posts and Telegraphs, which had the mandate to regulate and provide these services. Public ownership over the next several decades hampered growth of the sector, leaving India's teledensity (defined as main lines per 100 inhabitants) among the lowest in the world: 0.4 in 1980 and 0.7 in 1990. The extremely high level of unfulfilled demand was evident from the long waiting lists and the willingness of Indian subscribers to pay large up-front payments for telephone connections.

The government initiated partial reforms in 1985, when the Department of Posts and Telegraphs was divided into separate entities, the Department of Posts and the Department of Telecommunications. In 1986 the government spun off basic telephone services in the two metropolitan cities of Delhi and Mumbai into a new public sector entity, the Mahanagar Telephone Nigam Limited. Overseas communication services were transferred to Videsh Sanchar Nigam Limited. Subsequently, the government ushered in the National Telecom Policy of 1994, which allowed private participation in both basic and cellular services. In 1997 the government enacted legislation to establish the Telecom Regulatory Authority of India.

The process of liberalization received further fillip in 1999 with the adoption of the New Telecom Policy of 1999, which permitted the entry of multiple players into all segments, including fixed line, cellular, and long distance telecommunications. Furthermore, the policy-making and service-providing functions of the Department of Telecommunications were separated; the latter were transferred to a new company, Bharat Sanchar Nigam Limited. In addition, the Telecom Regulatory Authority of India Act was amended in 2000, to bring clarity to the authority's functions and powers, and a separate Telecom Disputes Settlement and Appellate Tribunal was established to adjudicate disputes.

In November 2003 the government issued guidelines for converging the hitherto disparate basic and cellular licenses into Unified Access Services Licenses. This process of license unification is likely to be extended to other service segments. Today, most major telecommunications operators are aggressively seeking to expand their