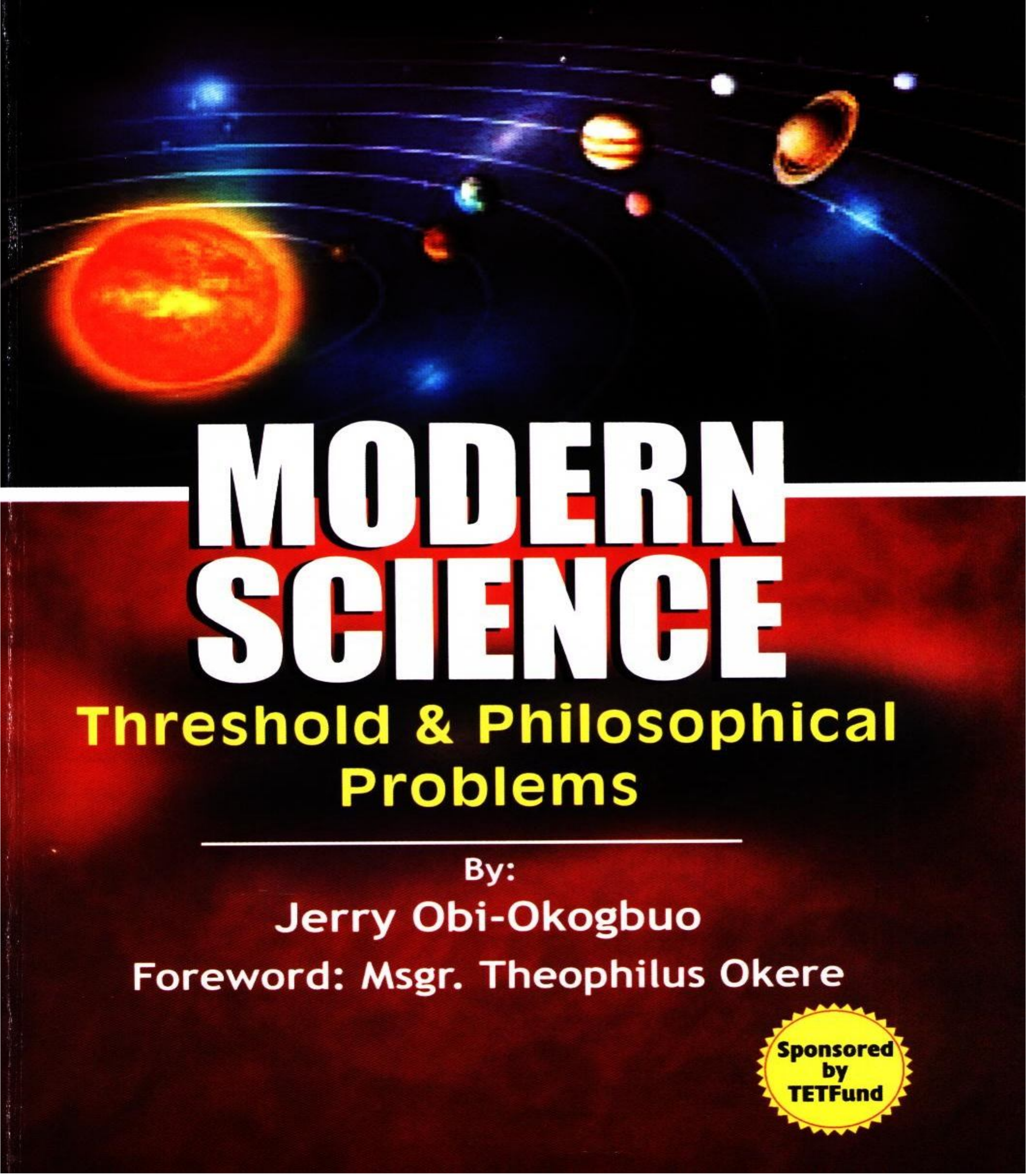
MODERN SCIENCE
Threshold & Philosophical Problems
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CHAPTER 10

THE INDUSTRIAL REVOLUTION

The Industrial Revolution could rightly be called the English Enlightenment. This assertion is based on the fact that the tone of the mid-eighteenth century middle-class Britain was unmistakably pragmatic. The fascination of the age was neither with theology nor with philosophy but with technology. This view is supported by the concern with practical activities of the Clubs and Societies established that time; for instance, the Society of Arts (1758); the Litchfield Circle and the Lunar Society. These were interested in practical and scientific matters. The Society of Arts during its early years concerned itself with bringing fish from the cost to London by road, thereby breaking the monopoly of Thames fish dealers and dramatically reducing the price of fish – this was a purely pragmatic concern.

The Industrial Revolution began in Britain in the mid-eighteenth century and spread to continental Europe and a few countries overseas. The metaphor of revolution applied to it was first used by a French-economist Adolphe Blanqui in 1827 and was made current in Europe by Karl Marx after 1848.

There is no general agreement regarding the periodization of the Industrial Revolution. What is worthy of note, however, is that although the "immense economic growth and change" known as Industrial Revolution became unmistakably noticeable in the mid-eighteenth century, the defeat of Jacobitism as a political force in England between 1708 and 1745 marked the passing away of pre-industrial society.

Ian Inkster defines Industrial Revolution as "the combination of structural efficiency and social changes which occurred between the years 1780 and 1850."[1] In real terms the classical Industrial Revolution which has Britain as its historical *locus* means the mechanization of numerous industrial operations, especially in the textile industry, which hitherto had been performed manually. It means the widespread adoption of new inanimate sources of power, especially the steam engines. Industrial Revolution is a radical technical change, the transformation of the Putting Out System, the Self-Sufficient Agrarian System, the Home-Made or

Domestic System, the Cottage Industry and the Craft Shop into the Factory System.

The factory system was an entirely new form of organization of production. It meant that the producers or workers no longer owned the means of production. The means of production now belonged to the capitalists. One of the important features of the factory system was the phenomenon of the division of labour. Adam Smith was one of the first to observe this feature and to note its direct impact in generating economic growth. Thus in simple terms, Industrial Revolution meant the radical and immense economic transformation of Britain in the mid-eighteenth century from agrarian to factory economic system.

The classical British Industrial Revolution contrasts with subsequent industrializations like that of Germany or Japan. The British Industrial Revolution is a three-sector economy: manufacturing, service industry and agriculture. Transformation was simultaneously going on in all these sectors. There were a lot of happenings from below. Industrialization, in Germany or Japan for instance, was from above. That meant the rise of the manufacturing sector which absorbed resources from other countries and then released them into the system; resources like improved institutions, technical progress, falling costs of transaction and growth in efficiency.

Tracing the link between knowledge and production, or to put it in a contemporary parlance, between science and technology or idea and progress, calls for a closer analysis of the Industrial Revolution. The nature of the relationship between knowledge and production during the Industrial Revolution is a contentious issue. While Freidrich Rapp posits "a causal nexus", Collin Russell "negates" the relationship, and David Landes "reverses" it. There are, however, two major stream models of the source of the innovations of the Industrial Revolution.

One stream holds that specific innovations of the Industrial Revolutions spring from inspired tinkerers. This model, the "materialist conception", or the technology-stream model, holds that mechanization (automation) did not begin or end with the invention of the steam engine by Peter Newcomb in 1705 or the improved steam engine by James Wath in 1764. This model traces the origins of the Industrial Revolution to the artisans and techniques of the Middle Ages. Geoffrey Bruun's account belongs to this model for he writes:

> The mechanization of industry which was to proceed at an unprecedented pace after 1750, did not result from a sudden change

> in manufacturing method, but from the rapid fruition and acceleration of technical improvements prepared in the preceding centuries. Without the progress of mechanics, without the construction of more powerful and intricate machines from the Middle Ages on, without the cult of precision which made accurate measurement a prerequisite, rendering duplication and standardization possible, there could have been no mechanization of industry. This mechanization was not merely the substitution of machine power for manpower; it was infinite duplication by a machine of specific activities which had once been performed, less consistently and far less speedily, by human hand. In preparing the way for this machine duplication, European man had not only to harness natural forces, water, wind or steam, but to develop instruments more accurate than his own senses and machines more delicate than his own fingers. Improvements in the clock, thermometer, air pump, microscope, piston, pendulum, and a hundred other devices, were all essential to technological progress. Inventors, who conceived improvements in machinery, often took their projects to the instrument-makers, who filed and ground the metal parts, which were then fitted together into a working model. Inventor and artisan were mutually interdependent.[2]

Indeed it is a fact that some of the earliest sciences emerged as a result of the efforts to meet simple practical human needs. The need to measure plots of land for agricultural purpose, for instance, led to Geometry. The needs in navigation led to the development of Astronomy. Consequently, the First Industrial Revolution (1750 – 1850) was brought about by self-taught men with limited, if any contact, with scholars. It was only in the last 50 years or thereabout that a symbiotic and synergistic relationship between science and technology were established.

The reason the role of science is doubted in the First Industrial Revolution can be explained by the fact that science during those days was still small and undifferentiated from natural philosophy. By the First Industrial Revolution, science had not taken a firm root. Too, at that time, science had nothing to show in terms of utility, which it could offer. All talk about the utility of science at that time was talk of future intentions. Also between 1700 and 1850 a good number of industrialists and people working in the industries were not university-educated. It was against such a background that specific innovations of the First Industrial Revolution were said not to have resulted from scientific knowledge but from inspired tinkerers, creative engineers, mechanics and designers (technologists) working with existing technological knowledge.

There appears to be consensus, however, on the "liberal conception", the science-stream model of the source of innovations in the Second Industrial Revolution (1850 – 1914). According to this model the Second and Third Industrial Revolutions would not have been possible without the availability of scientific knowledge; particularly the knowledge of the science of chemistry and physics. From the Second Industrial Revolution, scientific information were readily available to industrialists in a way that it stimulated Industrial Revolution. Physicists and chemists were in intimate contact with leading figures in British industry. There was intimate contact between the laboratory and the workshop such that innovators, contrivers, industrialists and entrepreneurs were not distinguishable one from the other. Hence from the Second Industrial Revolution, scientific and technological knowledge diffused both more widely and more broadly.

The diffusion of scientific information was made possible by the existence of numerous institutions, associations, academies and discussion groups designed for social purposes such as lectures, production of journals, information generation and dispersal. These institutions formed a kind of information network and information pool. They included Liverpool School of Design (1812); Liverpool Marine School (1815); Liverpool Apprentices and Mechanics Library (1823); Liverpool Mechanics' Institute (1825); Clarence Foundry Mutual Improvement Society or Edge-Hill Mechanics Club, and many other scientific and technical fora even outside the city of Liverpool. These institutions were instituted by intellectuals and industrialists. And they admitted all kinds of people: professionals, merchants, manufacturers, small businessmen, skilled tradesmen, artisans and other working class or middle class groups. The institutions gave lectures and they had museums and laboratories. These institutions account for the availability of technical, research, and invention-information that accentuated Industrial Revolution. It was during this time that the scientific ideas of mechanical philosophers of the scientific revolution were first applied in the field of power technology. Galileo had theorized that in a perfect friction-free machine there is no loss of "force", so that the effort put in must equal the useful effect obtained. This advance made possible such eighteenth and early nineteenth centuries measures as 'duty', 'horse power' and 'work' which contributed to the development of energy.

Science was able to positively and directly impact the Second Industrial Revolution because at this time science had taken firm root, was matured and bigger. By this time, it was possible to distinguish within what was previously natural philosophy autonomous areas of research like physics, chemistry, geology and so on. By this time science was becoming a profession with professionals (scientists) engaged in it and making a living out of it.

The two streams, the liberal and materialist conceptions, are being reconciled. Although scientific ideas tremendously gave a push to progress during the Industrial Revolution, it should not be understood to mean that scientific ideas were simply and directly applied to yield or create these innovations. What happened was that the new scientific ideas were absorbed into the existing traditions of praxis. Hence it is a more accurate picture to regard ideas and praxis as interacting more closely in the sense of exchanging relevant information and insights and theories. This is a more accurate view of the relationship between ideas and praxis during and after the Second Industrial Revolution. None of the two streams was singularly a more important source of new products.

REFERENCES

[1]Ian Inkster, *Science and Technology in History: An Approach to Industrial Development*, London: MacMillan, 1991, P.60

[2]Geoffrey Bruun, *Europe in Evolution*, New York: Houghton Mifflin, 1945, P.470-71