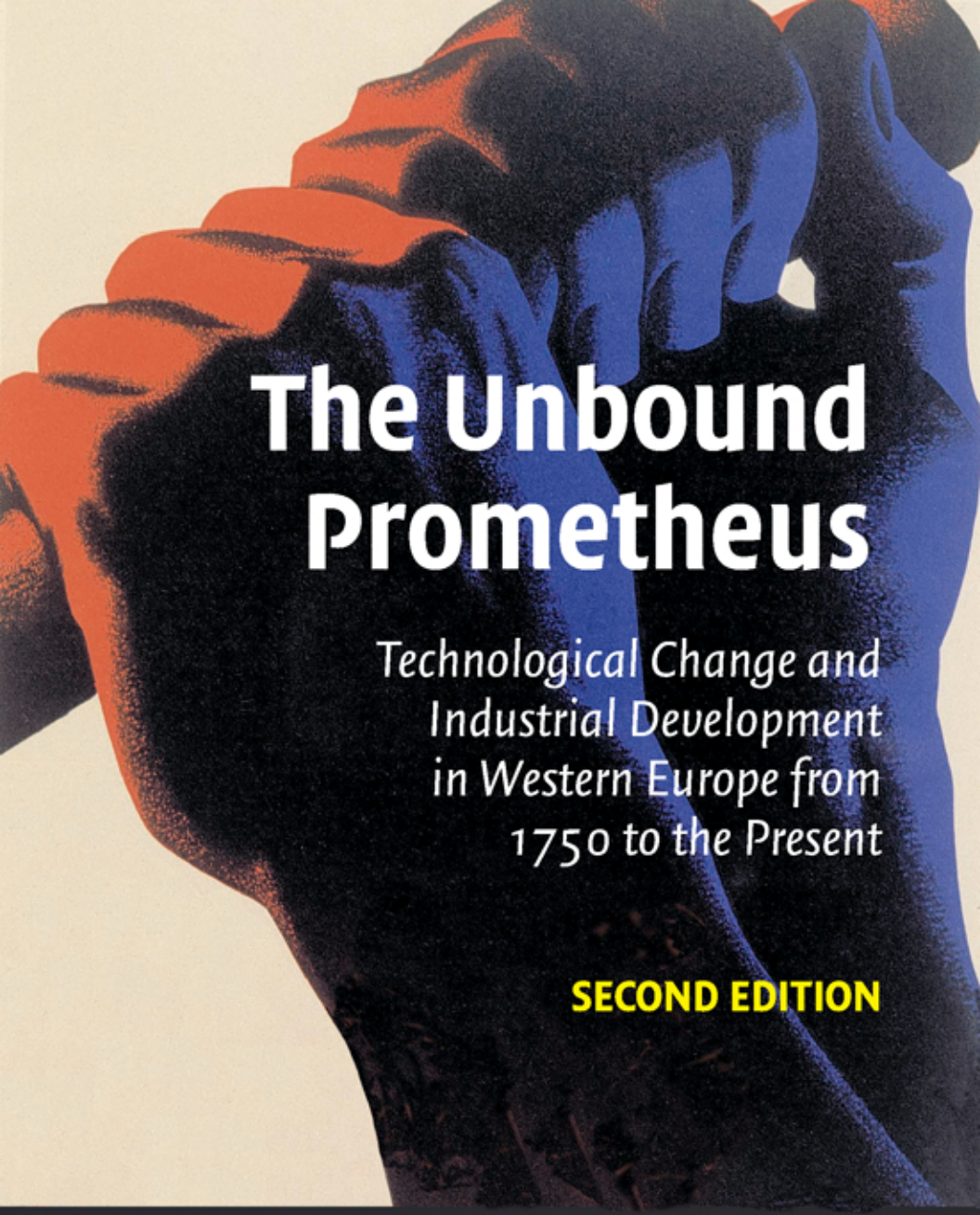

The Unbound Prometheus

Technological Change and Industrial Development in Western Europe from 1750 to the Present

SECOND EDITION

DAVID S. LANDES

CAMBRIDGE

THE UNBOUND PROMETHEUS

Technological change and industrial development in Western Europe from 1750 to the present

For over thirty years David S. Landes's *The Unbound Prometheus* has offered an unrivalled history of industrial revolution and economic development in Europe. Now, in this new edition, the author reframes and reasserts his original arguments in the light of current debates about globalization and comparative economic growth.

The book begins with a classic account of the characteristics, progress, and political, economic and social implications of the Industrial Revolution in Britain, France and Germany. Professor Landes here raises the much-debated question: why was Europe the first to industrialize? He then charts the economic history of the twentieth century: the effect of the First World War in accelerating the dissolution of the old international economy; the economic crisis of 1929–32; Europe's recovery and unprecedented economic growth following the Second World War. He concludes that only by continuous industrial revolution can Europe and the world sustain itself in the years ahead.

DAVID S. LANDES is Emeritus Coolidge Professor of History and Professor of Economics at Harvard University and the author of *The Wealth and Poverty of Nations* (1998).

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PREFACE

This study has a long history. It goes back to 1954, when Professor M. M. Postan asked me to write a chapter on technological change and industrial development in western Europe for the Cambridge Economic History. The subject was vast and I was soon caught up in the seamless web of the historian's history; so that by the time I had reached what seemed to me to be a convenient stopping place—that point, around 1870, when the leading industrial nations of continental Europe had effected their own breakthroughs to a modern economic system and were prepared to compete with Britain on even terms—I had far exceeded the space originally allotted to me. Even so, the editors of the Cambridge Economic History felt that it was not a good idea for my chapter to deviate in this manner from the general pattern of the larger volume, which was to take the story into the twentieth century; and they asked me to add a section on the period from 1870 to World War I. This was in 1958. I submitted a draft of the additional material in 1960, revised it somewhat in 1961–2, and the entire essay finally appeared in Volume VI of the Cambridge Economic History in 1965. Publication is a long and painful parturition.

By his time, what had begun as a chapter was as long as a book, and I thought, as did a number of readers, that it ought to appear as such. For one thing, the story was one that could stand on its own, even though certain aspects of European development—in particular, agriculture, transportation, population—had been reserved by the editors for treatment in other chapters; hence the deliberate use of 'Industrial Development' in the title. For another, there was a manifest need for a general, truly comparative survey of the course of the European industrial revolution. The nearest thing to this in English has been the textbooks in economic history currently used in American colleges and universities, but a textbook has very different objectives from an interpretive essay, and these in any case go back to before World War II. Since Volume VI of the Cambridge Economic History (a double volume) is too costly for all but the most affluent students, it seemed desirable to bring the essay out separately in a less expensive format. The officers of the Cambridge University Press were good enough to accept this reasoning and encourage me in this project.

The prospect of a new edition of the essay immediately posed a

difficult choice. On the one hand, the officers of the Press felt that the book would have considerably more usefulness if the story could be brought up to date, and this entailed a substantial research and writing commitment at a time when new university and personal obligations left me even less free time than usual. On the other, here was an opportunity to revise the original text to take into account the new work in European economic history that had appeared since the first writing; and given the time that had elapsed and the rapid pace of research in this field, this too was a large task. It was clear, however, that any effort to do both would delay publication considerably.

I chose to do the former, that is, bring the story up to the present, on the ground that this would do more to meet the specific needs of the constituency to which the book is directed. It remains my intention to bring out a fully revised version of the original essay. What I should like to do is not only add and modify as required by the latest findings, but broaden the geographical perspective and give more attention to the countries on the periphery of the western European industrial heartland: Scandinavia, Holland, the Mediterranean countries, the area once comprised in the Austrian empire. This, I fear, will be an even bigger job than the preparation of the chapters on the period since 1914. In the meantime, I have made a few changes in that part of the text that deals with the Industrial Revolution in Britain. This was the oldest part (the first draft goes back to 1957); also it deals with the area where research has been most active and productive. These changes, however, are not the equivalent of a systematic revision. Rather they reflect some of my own special interests and are unevenly dispersed through the chapter. The other sections remain as before, save for some corrections of errors of fact or print.

Given the format of the Cambridge Economic History, I was not able, at the time of publication of the original essay, to thank the many institutions and persons who had assisted me in its preparation and writing. The list of obligations has since grown much longer, and I am delighted to have this opportunity to express my gratitude. I shall not try to list by name the individuals who helped me with their criticism and counsel. The list would be far too long, and in view of the history of this project, I would inevitably commit the injustice of omitting some. Suffice it to say that I have profited from the knowledge and wisdom of some of the best men in history, economics, economic history, and related disciplines; and that whatever the merits or defects of this essay, it is far better than it would have been had I been confined to my own resources. To all of these friends and colleagues, I am grateful.

I should also like to express my gratitude to those institutions and foundations that made it possible for me to do this research and live and

consult with other scholars; the Center for Advanced Study in the Behavioral Sciences in Stanford, California (I was a fellow of the class of 1957–8, which brought together one of the most brilliant groups of economists ever assembled in one place for a protracted period of dialogue and interaction); the Institute of Industrial Relations of the University of California, Berkeley; the Rockefeller Foundation; the Social Science Research Council; the Program for Technology and Society of Harvard University (I have had the good fortune to participate in an interdisciplinary Study Group that has done much to clarify for me the course and character of contemporary technological change); and two informal dinner groups of economists and economic historians—the first a Berkeley–Stanford partnership, the second a union of interested persons from Harvard and M.I.T. In all of these contexts I have never failed to receive the kind of keen, candid criticism that is the hallmark of true friendship and disinterested scholarship.

Finally, I want to express special thanks to two friends who have been engaged with me in the preparation of another work, a history of the Berlin banking house of S. Bleichröder: Prof. Fritz Stern of Columbia University and Mr F. H. Brunner of Arnhold and S. Bleichröder, New York. They have stood by patiently and understandingly while I devoted a large share of my free time to a project that has proved far bigger than I had originally anticipated. I only hope I can repay them.

D.S.L.

Harvard University
April 1968

PREFACE TO THE NEW EDITION

'Revolution' is a potently ambivalent word. In one sense, it means a turning, a deep change. In another, it means a quick change, typically political in character. Both meanings are strong enough to elicit sentiments, often keen sentiments, of approval or disapproval. Not everyone likes change, but those who want the world to be different often yearn for it.[1]

The notion of an Industrial Revolution—deep transformation of the mode of production—goes back a couple of centuries, almost as far as the first appearance of those techniques that constituted the transformation. Adam Smith already alluded to the link between new ways and new riches, between new ways and international competition, in *The Wealth of Nations*, published in the great year of 1776. This new technology entailed not only the making and use of productive tools and machines, inventions and innovations, but new modes of labour organization and concentration, sometimes summed up in the term 'factory system'. And these gave rise in turn to a literature of criticism and protest on behalf of the working population (alias working classes), most prominently tied to Karl Marx and Friedrich Engels in the fourth and fifth decades of the nineteenth century. These anti-capitalist writings have continued to influence thought and judgment, partly because of their link to still viable political action, partly because of moral and ethical resentment and repudiation of the new forms of wealth that have emerged from modern industry and its economic consequences.

By the end of the century, we have the first published uses of 'industrial revolution' as designation for the changes that had transformed the mode of production; thus Arnold Toynbee's *Lectures on the Industrial Revolution of the 18th Century in England* (1902). The British were quickest to adopt the new terminology; after all, it had been their revolution to start with. Others were slower and in some instances reluctant, partly because of unwillingness to concede so important a role to those arrogant, pretentious islanders off the European coast, partly because of distaste for the changes.

Still, such ideological and emotional intrusions can only handicap the victims. They find it only too easy to substitute whining for doing. The industrial revolution had revolutionized industry and brought the

[1] Cf. Roy Porter and Mikuláš Teich, eds., *Revolution in History* (Cambridge: Cambridge University Press, 1986).

world into a new era of monotonic technological progress. For richer and better, mankind was now set on a path of persistent innovation and development. The rich got richer, and the poor, even where better off in an absolute sense, saw the gap grow that set them apart. In the material sense, this was the birth of the modern, and Europe was the mother.

But birth implies pregnancy, and one of the most divisive issues of the revolution is the question how far back to look for its origins. For some, the story begins with those early textile inventions and the new metallurgical techniques—so, take-off *de novo* in the 1760s. The trouble with that approach, however, is that factually accurate though it may be, it impoverishes our understanding of a major historical development: how and why did revolution come to pass. In particular, why in Europe and why especially in northern and northwestern Europe.

I deal with some of this in my Introduction, but only some, with emphasis on those cultural, institutional and intellectual differences that permitted and shaped the specifically European gains in science and technology. I should have done more, but in those days (the 1950s and '60s) the issue seemed less pertinent, even irrelevant, by the definition of the problem. But it has since become germane, even a matter of controversy. The more recent attention to inter-civilizational comparisons has made the timing of European industrialization a matter of heated debate, especially between specialists of Chinese history (sinologues, usually sinophiles) and students of European performance. A strong contingent of sinologues, sceptical if not resentful of European claims to early priority, have advanced the contention that China, contrary to long-held assumptions, had higher income and standard of living than Europe until well into the eighteenth century. In other words, it was the Industrial Revolution in the narrow sense (machines and more machines) and only the Industrial Revolution that finally enabled the West to catch up with and pass China; that it was this chance—yes, some would say chance—that spelled the difference and led to the great West–East gap. This rejection of received wisdom, this major historical revision, has been for some of these sinologues a useful, even necessary, correction of Western complacency and arrogance.

But such corrections, however satisfying or salutary, must yield to fact and truth. Western sinophiles might take comfort therein, but Chinese historians know better. They know for example that China had not only lost its interest in technological innovation but had made a major mistake in failing to respond to and emulate those novelties that European visitors brought with them from the sixteenth century on—in short, had made a monumental error that cost some four hundred years of potential development. Yes, Europe had long lagged China (and Islam) in these respects but then started catching up in the late Middle Ages and passed

them by the fifteenth century. It was not an accident that it was the West that rounded Africa and opened Asian waters to exploration, plunder and trade; or for that matter, that it took another 350 years for the first Chinese ship to round Africa and sail the Atlantic. By the middle of the second millennium, the years of discovery and the opening of the world to European vessels, the one-time backwater had left its predecessors far behind.

The record of this tacit competition suggests that one of the major considerations in any comparative analysis is the response to challenge—the ability of an economy to deal effectively with change and its collateral effects. Much of the development of the last thousand years revolves around such conflicts, not only as between West and Rest (especially China and Islam), but as between early and late starters within Europe. The first cities and polities to take off were Mediterranean, only to yield to the Low Countries and British Isles from the seventeenth century on.

This shift has been the subject of a vast literature, much of it stressing the religious and institutional differences between North and South and their effects on behaviour and social attitudes. (See the Introduction that follows.) But that is only part of the story, and here too, the theme of response to challenge and the threat of relative decline throws new light on old topics. On the larger issue, Carlo Cipolla's collection of essays on the *Economic Decline of Empires* (1970) is an eye-opener; see especially his own essay on 'The Economic Decline of Italy'.[2]

It makes me feel the need to write another book.

[2] See also Peter Burke, *Venice and Amsterdam: A Study of Seventeenth-Century Elites* (2nd edn; Cambridge and Oxford: Polity Press and Blackwell, 1994); and Alain Peyrefitte, *Du "miracle" en économie. Leçons au Collège de France* (Paris: Odile Jacob, 1995).

CHAPTER I

Introduction

When dealing with ambiguous terms, the first duty of a writer is definition. The words 'industrial revolution'—in small letters—usually refer to that complex of technological innovations which, by substituting machines for human skill and inanimate power for human and animal force, brings about a shift from handicraft to manufacture and, so doing, gives birth to a modern economy. In this sense, the industrial revolution has already transformed a number of countries, though in unequal degree; other societies are in the throes of change; the turn of still others is yet to come.

The words sometimes have another meaning. They are used to denote any rapid significant technological change, and historians have spoken of an 'industrial revolution of the thirteenth century', an 'early industrial revolution', the 'second industrial revolution', an 'industrial revolution in the cotton south'. In this sense, we shall eventually have as many 'revolutions' as there are historically demarcated sequences of industrial innovation, plus all such sequences as will occur in the future; there are those who say, for example, that we are already in the midst of the third industrial revolution, that of automation, air transport, and atomic power.

Finally, the words, when capitalized, have still another meaning. They denote the first historical instance of the breakthrough from an agrarian, handicraft economy to one dominated by industry and machine manufacture. The Industrial Revolution began in England in the eighteenth century, spread therefrom in unequal fashion to the countries of Continental Europe and a few areas overseas, and transformed in the span of scarce two lifetimes the life of Western man, the nature of his society, and his relationship to the other peoples of the world. The Industrial Revolution, as it took place in western Europe, is the subject of this book.

The heart of the Industrial Revolution was an interrelated succession of technological changes. The material advances took place in three areas: (1) there was a substitution of mechanical devices for human skills; (2) inanimate power—in particular, steam—took the place of human and animal strength; (3) there was a marked improvement in the getting and working of raw materials, especially in what are now known as the metallurgical and chemical industries.

Concomitant with these changes in equipment and process went new forms of industrial organization. The size of the productive unit grew: machines and power both required and made possible the concentration of manufacture, and shop and home workroom gave way to mill and factory. At the same time, the factory was more than just a larger work unit. It was a system of production, resting on a characteristic definition of the functions and responsibilities of the different participants in the productive process. On the one side was the employer, who not only hired the labour and marketed the finished product, but supplied the capital equipment and oversaw its use. On the other side there stood the worker, no longer capable of owning and furnishing the means of production and reduced to the status of a hand (the word is significant and symbolizes well this transformation from producer to pure labourer). Binding them were the economic relationship—the 'wage nexus'—and the functional one of supervision and discipline.

Discipline, of course, was not entirely new. Certain kinds of work—large construction projects, for example—had always required the direction and co-ordination of the efforts of many people; and well before the Industrial Revolution there were a number of large workshops or 'manufactories' in which traditional unmechanized labour operated under supervision. Yet discipline under such circumstances was comparatively loose (there is no overseer so demanding as the steady click-clack of the machine); and such as it was, it affected only a small portion of the industrial population.

Factory discipline was another matter. It required and eventually created a new breed of worker, broken to the inexorable demands of the clock. It also held within itself the seeds of further technological advance, for control of labour implies the possibility of the rationalization of labour. From the start, the specialization of productive functions was pushed farther in the factory than it had been in shops and cottages; at the same time, the difficulties of manipulating men and materials within a limited area gave rise to improvements in layout and organization. There is a direct chain of innovation from the efforts to arrange the manufacturing process so that the raw material would move downwards in the plant as it was treated, to the assembly line and transmission belts of today.

In all of this diversity of technological improvement, the unity of the movement is apparent: change begat change. For one thing, many technical improvements were feasible only after advances in associated fields. The steam engine is a classic example of this technological interrelatedness: it was impossible to produce an effective condensing engine until better methods of metal working could turn out accurate cylinders. For another, the gains in productivity and output of a given

innovation inevitably exerted pressure on related industrial operations. The demand for coal pushed mines deeper until water seepage became a serious hazard; the answer was the creation of a more efficient pump, the atmospheric steam engine. A cheap supply of coal proved a godsend to the iron industry, which was stifling for lack of fuel. In the meantime, the invention and diffusion of machinery in the textile manufacture and other industries created a new demand for energy, hence for coal and steam engines; and these engines, and the machines themselves, had a voracious appetite for iron, which called for further coal and power. Steam also made possible the factory city, which used unheard-of quantities of iron (hence coal) in its many-storied mills and its water and sewage systems. At the same time, the processing of the flow of manufactured commodities required great amounts of chemical substances: alkalis, acids, and dyes, many of them consuming mountains of fuel in the making. And all of these products—iron, textiles, chemicals—depended on large-scale movements of goods on land and on sea, from the sources of the raw materials into the factories and out again to near and distant markets. The opportunity thus created and the possibilities of the new technology combined to produce the railroad and steamship, which of course added to the demand for iron and fuel while expanding the market for factory products. And so on, in ever-widening circles.

In this sense, the Industrial Revolution marked a major turning point in man's history. To that point, the advances of commerce and industry, however gratifying and impressive, had been essentially superficial: more wealth, more goods, prosperous cities, merchant nabobs. The world had seen other periods of industrial prosperity—in medieval Italy and Flanders, for example—and had seen the line of economic advance recede in each case; in the absence of qualitative changes, of improvements in productivity, there could be no guarantee that mere quantitative gains would be consolidated. It was the Industrial Revolution that initiated a cumulative, self-sustaining advance in technology whose repercussions would be felt in all aspects of economic life.

To be sure, opportunity is not necessarily achievement. Economic progress has been uneven, marked by spurts and recessions, and there is no reason to be complacent about the prospect of an indefinite climb. For one thing, technological advance is not a smooth, balanced process. Each innovation seems to have a life span of its own, comprising periods of tentative youth, vigorous maturity, and declining old age. As its technological possibilities are realized, its marginal yield diminishes and it gives way to newer, more advantageous techniques. By the same token, the divers branches of production that embody these techniques follow their own logistic curve of growth toward a kind of asymptote.

Thus the climb of those industries that were at the heart of the Industrial Revolution—textiles, iron and steel, heavy chemicals, steam engineering, railway transport—began to slow toward the end of the nineteenth century in the most advanced west European countries, so much so that some observers feared that the whole system was running down. (At this point, the Industrial Revolution in these countries was substantially complete.) Similar dire prognoses accompanied the world depression of the 1930's, particularly by those Marxist critics who saw the capitalist economy as incapable of sustained creativity. In fact, however, the advanced industrial economies have given proof of considerable technological vitality. The declining momentum of the early-modernizing branches in the late nineteenth century was more than compensated by the rise of new industries based on spectacular advances in chemical and electrical science and on a new, mobile source of power—the internal combusion engine. This is the cluster of innovations that is often designated as the second industrial revolution. Similarly, the contraction of the 1930's has been followed by decades of unusual creativity, consisting once again primarily in innovations in the application of chemical and electrical science, plus advances in the generation and delivery of power —the abovementioned third industrial revolution.

A more serious cause of concern lies outside the productive system proper—in the area of political economy and politics *tout court*. Even assuming that the ingenuity of scientists and engineers will always generate new ideas to relay the old and that they will find ways to overcome such shortages as may develop (whether of food, water, or industrial raw materials), there is no assurance that those men charged with utilizing these ideas will do so intelligently—intelligently, that is, not only in the sense of effective exploitation of their productive possibilities but in the larger sense of effective adaptation to the material and human environment so as to minimize waste, pollution, social friction, and other 'external' costs. Similarly, there is no assurance that noneconomic exogenous factors—above all, man's incompetence in dealing with his fellow-man—will not reduce the whole magnificent structure to dust.

In the meantime, however, the climb has been spectacular. Improvements in productivity of the order of several thousand to one have been achieved in certain sectors—prime movers and spinning for example. In other areas, gains have been less impressive only by comparison: of the order of hundreds to one in weaving, or iron smelting, or shoemaking. Some areas, to be sure, have seen relatively little change: it still takes about as much time to shave a man as it did in the eighteenth century.

Quantitative gains in productivity are, of course, only part of the

picture. Modern technology produces not only more, faster; it turns out objects that could not have been produced under any circumstances by the craft methods of yesterday. The best Indian hand spinner could not turn out yarn so fine and regular as that of the mule; all the forges in eighteenth-century Christendom could not have produced steel sheets so large, smooth, and homogeneous as those of a modern strip mill. Most important, modern technology has created things that could scarcely have been conceived in the pre-industrial era: the camera, the motor car, the aeroplane, the whole array of electronic devices from the radio to the high-speed computer, the nuclear power plant, and so on almost *ad infinitum*. Indeed, one of the primary stimuli of modern technology is free-ranging imagination; the increasing autonomy of pure science and the accumulation of a pool of untapped knowledge, in combination with the ramifying stock of established technique, have given ever wider scope to the inventive vision. Finally, to this array of new and better products—introduced, to be sure, at the expense of some of the more artistic results of hand craftsmanship—should be added that great range of exotic commodities, once rarities or luxuries, that are now available at reasonable prices thanks to improved transportation. It took the Industrial Revolution to make tea and coffee, the banana of Central America and the pineapple of Hawaii everyday foods. The result has been an enormous increase in the output and variety of goods and services, and this alone has changed man's way of life more than anything since the discovery of fire: the Englishman of 1750 was closer in material things to Caesar's legionnaires than to his own great-grandchildren.

These material advances in turn have provoked and promoted a large complex of economic, social, political, and cultural changes, which have reciprocally influenced the rate and course of technological development. There is, first, the transformation that we know as *industrialization*. This is the industrial revolution, in the specifically technological sense, plus its economic consequences, in particular the movement of labour and resources from agriculture to industry. The shift reflects the interaction of enduring characteristics of demand with the changing conditions of supply engendered by the industrial revolution. On the demand side, the nature of human wants is such that rises in income increase the appetite for food less than for manufactures. This is not true of people who have been living on the borderline of subsistence; they may use any extra money to eat better. But most Europeans were living above this level on the eve of industrialization; and although they did spend more for food as income went up, their expenditures on manufactures increased even faster. On the supply side, this shift in demand was reinforced by the relatively larger gains in industrial as against

agricultural productivity, with a consequent fall in the price of manufactures relative to that of primary products.

Whether this disparity is inherent in the character of the industrial process, in other words, whether manufacture is intrinsically more susceptible of technological improvement than cultivation and husbandry, is an interesting but moot question. The fact remains that in the period of the Industrial Revolution and subsequently, industry moved ahead faster, increased its share of national wealth and product, and drained away the labour of the countryside. The shift varied from one country to another, depending on comparative advantage and institutional resistance. It was most extreme in Britain, where free trade stripped the farmer of protection against overseas competition; by 1912, only 12 per cent of Britain's labour force was employed in agriculture; by 1951, the proportion had fallen to an almost irreducible 5 per cent. And it was slowest in France, a country of small landholders, where a more gradual introduction of the new industrial technology combined with high tariffs on food imports to retard the contraction of the primary sector. Over half the French labour force was in agriculture in 1789 (perhaps 55 per cent or more), and this was still true in 1866, after three quarters of a century of technological change; as recently as 1950, the proportion was still a third.[1]

Industrialization in turn is at the heart of a larger, more complex process often designated as *modernization*. This is that combination of changes—in the mode of production and government, in the social and institutional order, in the corpus of knowledge and in attitudes and values—that makes it possible for a society to hold its own in the twentieth century; that is, to compete on even terms in the generation of material and cultural wealth, to sustain its independence, and to promote and accommodate to further change. Modernization comprises such developments as urbanization (the concentration of the population in cities that serve as nodes of industrial production, administration, and intellectual and artistic activity); a sharp reduction in both death rates and birth rates from traditional levels (the so-called demographic transition); the establishment of an effective, fairly centralized bureaucratic government; the creation of an educational system capable of training and socializing the children of the society to a level compatible with their capacities and best contemporary knowledge; and of course, the acquisition of the ability and means to use an up-to-date technology.

All of these elements are interdependent, as will become apparent in

[1] Simon Kuznets, *Six Lectures on Economic Growth* (Glencoe, Ill. 1959), pp. 50–1; J. C. Toutain, *La population de la France de 1700 à 1959* [J. Marczewski, ed., *Histoire quantitative de l'économie française*, vol. III], in *Cahiers de l'Institut de Sciences Economiques Appliquées*, Series AF, no. 3, Suppl. no. 133 (January, 1963), p. 127.

the discussion that follows, but each is to some degree autonomous, and it is quite possible to move ahead in some areas while lagging in others—witness some of the so-called developing or emerging nations of today. The one ingredient of modernization that is just about indispensable is technological maturity and the industrialization that goes with it; otherwise one has the trappings without the substance, the pretence without the reality.

It was Europe's good fortune that technological change and industrialization preceded or accompanied *pari passu* the other components of modernization, so that on the whole she was spared the material and psychic penalties of unbalanced maturation. The instances of marked discrepancy that come to mind—the effort of Peter to force the westernization of a servile society in Russia, the explosion of population in Ireland in a primitive and poor agricultural environment, the urbanization of Mediterranean Europe in the context of a pre-industrial economy—yielded a harvest of death, misery, and enduring resentment.

Even so, industrial Europe had its own growing pains, which were moderate only by comparison with extreme cases of accelerated modernization or with the deep poverty and suffering of that outer world (the so-called Third World) of technologically backward, non-industrializing societies in Asia, Africa, and Latin America. For one thing, if mechanization opened new vistas of comfort and prosperity for all men, it also destroyed the livelihood of some and left others to vegetate in the backwaters of the stream of progress. Change is demonic; it creates, but it also destroys, and the victims of the Industrial Revolution were numbered in the hundreds of thousands or even millions. (On the other hand, many of these would have been even worse off without industrialization.) By the same token, the Industrial Revolution tended, especially in its earlier stages, to widen the gap between rich and poor and sharpen the cleavage between employer and employed, thereby opening the door to class conflicts of unprecedented bitterness. It did not create the first true industrial proletariat: the blue-nails of medieval Flanders and the Ciompi of the Florence of the *quattrocento* are earlier examples of landless workers with nothing to sell but their labour. Indeed, as we shall see, the putting-out system was in its day as productive of class hostility as the factory. But the eighteenth and nineteenth centuries did see the growth of a working class more numerous and concentrated than ever before. And with size and concentration came slums and class consciousness, workers' parties and radical panaceas.

In similar fashion, the Industrial Revolution generated painful changes in the structure of power. It did not create the first capitalists, but it did produce a business class of unprecedented numbers and strength. The hegemony of landed wealth, long threatened by the mobile fortunes of

commerce but never overturned, yielded to the assaults of the new chimney aristocrats. Largely as the result of a series of revolutions, domestic government policy came to be determined in most of western Europe by the manufacturing interest and its allies in trade and finance, with or without the co-operation of the older landed establishment. In central Europe—Germany and Austria-Hungary—the picture was different: the attempt at revolution failed, and the aristocracy continued to hold the reins of government; business ambitions were subordinated to, rather than identified with, the goals of unity and power. Even there, however, the growing wealth and influence of the industrial and commercial bourgeoisie was apparent in the course of legislation and in the penetration by parvenus of the social and occupational strongholds of the old elites. In the course of the nineteenth century, much of the privileged knights' land (*Rittergüter*) of east-Elbian Prussia came into the hands of commoners; while from 1870 to 1913, the proportion of aristocrats in the officer corps of the Prussian army fell from 70 to 30 per cent.[1]

To be sure, this kind of victory often spelled a kind of defeat: the rising bourgeois could be more snobbish than the blooded nobleman, stiffer and more arrogant than a Junker guardsman. Whereas in Britain and France, the new business elite competed for power, in Germany they acquiesced in the status quo and sold their liberal birthright for a mess of chauvinistic pottage seasoned by commercial legislation and administration favourable to business enterprise. The fact remains that they did have to be bought off; and indeed everywhere the balance of status and power shifted, in greater or lesser degree, from the older landed elite toward the new rich of industry and trade.

Two of the factors conducing in this direction were the separation of the aristocracy from the mass of the country population and the general decline of rural forces in national life. Partly (though only partly) owing to industrialization, the traditional system of land tenure, with its vestiges of feudal privileges and its tenacious communal rights, was replaced by one of unlimited ownership of enclosed parcels. A certain amount of the traditional paternalistic authority of the 'lord of the manor' was lost in the process, especially in those regions where the changed was forced. Even more important, however, was a progressive anaemia of rural life: on the one hand, a massive exodus to the cities at the expense of marginal lands; on the other, an invasion of agricultural areas by industry—how green was my valley!

The growth of a factory proletariat, the rise of the industrial bour-

[1] Hans Rosenberg, 'Die Pseudodemokratisierung der Rittergutsbesitzerklasse', in H. U. Wehler, ed., *Moderne deutsche Sozialgeschichte* (Cologne and Berlin, 1966), pp. 287–308; Karl Demeter, *Das deutsche Offizierkorps in Gesellschaft und Staat 1650–1945* (Frankfurt-am-Main, 1962), p. 26.

geoisie and its progressive merger with the old elite, the ebbing resistance of the peasantry to the lure of the city and to the competition of new ways and a new scale of cultivation—all of these trends encouraged some observers to predict a polarization of society between a large mass of exploited wage earners and a small group of exploiting owners of the means of production. The trend to size and concentration seemed inexorable and pervasive. Every advance in technology seemed to hurt the ability of the small, independent operator to survive in the impersonally competitive market place.

Yet this was a serious misreading of the course of change. Mass production and urbanization stimulated, indeed required, wider facilities for distribution, a larger credit structure, an expansion of the educational system, the assumption of new functions by government. At the same time, the increase in the standard of living due to higher productivity created new wants and made possible new satisfactions, which led to a spectacular flowering of those businesses that cater to human pleasure and leisure: entertainment, travel, hotels, restaurants, and so on. Thus the growth of a factory labour force was matched by a proliferation of service and professional people, white-collar workers, functionaries, engineers, and similar servants of the industrial system and society. Indeed, as productivity rose and the standard of living with it, this administrative and service sector of the economy—what some economists have called the tertiary sector—grew more rapidly than industry itself.

In sum, the Industrial Revolution created a society of greater richness and complexity. Instead of polarizing it into bourgeois minority and an almost all-embracing proletariat, it produced a heterogeneous bourgeoisie whose multitudinous shadings of income, origin, education, and way of life are overridden by a common resistance to inclusion in, or confusion with, the working classes, and by an unquenchable social ambition.

For the essence of the bourgeois is that he is what the sociologists call upwardly mobile; and nothing has ever furnished so many opportunities to rise in the social scale as the Industrial Revolution. Not everyone seized these opportunities. For many, the shift from country to city, from farm to industry or trade, marked simply the exchange of one labouring status for another. The factory worker could be, and usually was, as tradition-bound in his expectations for himself and his children as the peasant. But for thousands, the move to town, or often to another region or country, marked a decisive break with the past; the migrant found himself afloat in a fluid society. Some rose and founded unexampled fortunes in their own lifetimes; others climbed slowly, generation by generation. For many, education was the open-sesame to

higher status, and this channel was in itself evidence of the more explicit functional requirements of a technologically advanced society. More and more, it became important to choose someone for a job or place on universalistic rather than particularistic grounds, on the basis of what he could do rather than who he was or whom he knew.

But universalism cuts both ways. While some rise on merit, others must fall; some succeed, but others fail. It has been said of political revolutions that they devour their children. So do economic revolutions. Thus the small machines of the early Industrial Revolution were succeeded by big ones; the little mills became giant factories; the modest partnerships were converted to large public companies; the victims and laggards of the early decades were succeeded by new victims and laggards. The resulting concentration of enterprise in certain sectors of the economy did not displace the small firm or make it obsolete. The very forces that promoted industrial and commercial giantism opened new possibilities for small ventures: service enterprises, distribution agencies, subcontractors, and so on. The fact remains, however, that smaller firms in traditional lines were pressed hard by bigger and more efficient competitors; many collapsed in spite of all the resistance, ingenuity, and sacrifice that old-style family enterprises are capable of. Both casualties and survivors proved easy converts for the preachers of discontent and reaction: in some countries they turned the government into the instrument of vested interests; in others, they became the troops of right-wing revolution.

For if the first effect of the Industrial Revolution was to shift drastically the balance of political power in favour of the commercial and industrial classes, subsequent economic development raised up new enemies of the liberal, parliamentary system that was the symbol and instrument of bourgeois government. On the one hand, there was concentrated, class-conscious industrial labour; on the other, the bourgeois victims of economic and social change: the marginal entrepreneurs, the discontented, the *déclassés*. Between the two extremes the gulf widened, as each reacted to the other. The World War brought the latent conflict to a head by stimulating the demands of labour while ravaging the savings of the bourgeoisie. In all countries, the postwar years saw a flow of political power outward from the centre to the extremes. In a nation like England, the result was a new party alignment and gradual movement to a new position of compromise. In countries like Germany and Italy, the resolution was more radical. In France, the centrifugal trend was countered by the distraction of logrolling; the heterogeneous special interests of the bourgeoisie found a *modus vivendi* in the manipulation of government on behalf of the status quo and at the expense of a divided labour movement.

In each case, of course, the nature of the political adaptation to the economic changes wrought by the Industrial Revolution was a function of the existing political structure and traditions, social attitudes, the particular effects of the war, and the differential character of economic development. For the Industrial Revolution, as we shall see, was not a uniform wave of change; nor did it roll up on like shores. On the contrary, it came to a great variety of places, with differing resources, economic traditions, social values, entrepreneurial aptitudes, and technological skills.

This unevenness of timing and distribution in turn has had the most serious consequences. Politically it has meant a complete revision of the balance of power. The basis of military strength has shifted from sheer numbers—and tactical inspiration—to industrial capacity, particularly the ability to turn out guns and munitions and move them to combat. Money was once the sinews of war because it could buy men; now it must produce fire power as well. As a result, the nineteenth century saw a unified Germany rise to Continental hegemony on the strength of the Ruhr and Silesia; while France, slower to industrialize, was never again to enjoy the pre-eminence to which the *levée en masse* and the genius of Napoleon had raised her on the eve of economic revolution. With the spread of the new techniques, moreover, new powers arose: the twentieth century saw the millennial predominance of Europe dwindle before the unprecedented might of the United States and Soviet Russia.

At the same time, the technological gap has made possible and economic interest has called forth a spectacular expansion of Western power in the preindustrial areas of the world; in this respect, the Industrial Revolution consummated the process begun by the voyages and overseas conquests of the fifteenth and sixteenth centuries. And while in recent decades the tide of imperial dominion has receded, it has left its indelible imprint wherever its waters have rolled: all of the undeveloped countries of the globe are converted to the religions of industry and wealth with a faith that surpasses that of their teachers. Never in the thousands of years of contact between civilizations has one of them enjoyed such universal success.

Yet up to now, at least, faith has not been enough. The nations of the Third World have yet to effect their industrial revolution, and the gulf in wealth and standard of living between them and the economically advanced countries has increased to the point of scandal and danger. The disparity has been aggravated by the partial character of their modernization. The West has brought them lower death rates, but not lower birth rates; so that population growth has eaten up, and in some instances outstripped, their gains in income. The West has provided

them with some education—enough to know their dependence and to dream of freedom, but not enough to create and operate a modern economy. It has given them a distorted underview, the view from the kitchen, the mine, and the labour camp, of the potentialities and rewards of an industrial technology—a tantalizing taste of what seems to be a material paradise; but it has not given them the means to satisfy the appetite thus engendered. It has also left them a memory of brutality and humiliation, a stain that some have argued can be erased only in blood.[1]

This is not to imply that the conduct of colonial powers has always been reprehensible or the consequences of their rule invariably bad. On the contrary, one could argue that many of the colonial peoples were better off under European rule than they have been since independence. But as we all know, the evil that men do lives after them; besides, most of the peoples in the world (with the possible exception of Puerto Rico) have opted for freedom even in mediocrity as against prosperity in subordination.

The explosive implications of this legacy of jealousy, frustration, hatred and alienation need not be laboured here.

In sum, the Industrial Revolution has been like in effect to Eve's tasting of the fruit of the tree of knowledge: the world has never been the same. (There is no point in arguing here whether the change is for the better or the worse. The question is one of ends more than means and has its place in moral philosophy, not economic history.)

* * * *

So much for the wider historical implications of the Industrial Revolution. For the economic historian *qua* economist, the problem has another side. His concern is with the processes of industrial change as such: how did they occur? why did they move faster in some places than others? why did they take different forms in different economies? In short, he is interested in the causes and process of growth.

From this point of view, the Industrial Revolution poses two problems: (1) why did this first breakthrough to a modern industrial system take place in western Europe? and (2) why, within this European experience, did change occur when and where it did?

The essay that follows is concerned with the second of these questions; but it will not be amiss to consider the first by way of introduction.

The first point that needs to be made is that Europe on the eve of the Industrial Revolution was a society that had already advanced a long

[1] The most powerful and popular expression of this thesis is the late Frantz Fanon's *Les damnés de la terre* (English translation: *The Wretched of the Earth* [London, 1965]).

way economically beyond the level of minimal subsistence. The significance of this advance is apparent from a comparison of such estimates as we can make of income per head in eighteenth-century England, say, and pre-industrial economies of the twentieth century. Phyllis Deane, who bases her calculations on the estimates of contemporary observers, tells us that the average for England and Wales at the end of the seventeenth century was about £9 per year;[1] in the 1750's, between £12 and £13. Given the revolution in consumption that has taken place since then, it is hazardous to convert these sums into their twentieth-century equivalents; but on the reasonable assumption that money was worth at least eight times as much 200 and 250 years ago (Miss Deane's multiplier of six is far too low), we are talking of incomes of about £70 in 1700, £100 a half-century later. Comparable figures for the France of the eighteenth century have to be inferred from even more precarious 'guesstimates'; but it seems reasonable to suppose that income per head was moderately lower than in Britain at the beginning and that it kept pace fairly well until the last quarter of the century.[2] By comparison, average annual income in Nigeria, one of the richer African countries, was about £30 per head in the early 1960's, while that of India was even lower—about £25. To find something comparable to the western European level of two centuries ago, one has to look at the already semi-industrialized countries of Latin America: Brazilian income *per capita* was some £95 per annum in 1961; Mexican income, about £105.[3]

Western Europe, in other words, was already rich before the Industrial Revolution—rich by comparison with other parts of the world of that day and with the pre-industrial world of today. This wealth was the product of centuries of slow accumulation, based in turn on investment, the appropriation of extra-European resources and labour, and

[1] Deane, *The First Industrial Revolution* (Cambridge, 1965), p. 6; cf. her earlier article, 'The Implications of Early National Income Estimates for the Measurement of Long-Term Economic Growth in the United Kingdom', *Econ. Devel. and Cult. Change*, IV, no. 1 (1955).

[2] In 1688, Gregory King estimated that income per head in Britain was higher than anywhere else in Europe except Holland; and that it was 20 per cent above that of France. On the course of French and British economic growth in the eighteenth century, see François Crouzet, 'Angleterre et France au XVIII[e] siècle: essai d'analyse comparée de deux croissances économiques', *Annales; économies, sociétés, civilisations*, XXI (1966), 270. J. Marczewski, 'Le produit physique de l'économie française de 1789 à 1913', *Histoire quantitative de l'économie française* (*Cahiers de l'I.S.E.A.*, AF, 4, no. 163 [July 1965]), p. lxxix, Table 30, shows English and French physical products per head as approximately equal at the start of the nineteenth century. From what is known of comparative productivities in the two economies and the effect of the Revolution on French industry, this comparison would seem to be too favourable to France.

[3] Deane, *The First Industrial Revolution*, p. 7.

substantial technological progress, not only in the production of material goods, but in the organization and financing of their exchange and distribution.

Economic growth in this period of preparation, as it were, was by no means continuous: there was a major setback in the late fourteenth and fifteenth centuries, in the aftermath of the Black Death; and certain parts of Europe suffered grievously and long in the following period from the effects of war and pestilence. Nor was the rate of growth at best anything like so rapid as it was to become during and after the Industrial Revolution. (We have no true statistical estimates of pre-modern growth; but one has only to extrapolate the levels of income prevalent on the eve of industrialization backward at the rates of growth prevailing after 1700, and one arrives very quickly at levels of income too low for human survival.) Indeed, there is good reason to believe that much of such economic growth as did take place was translated into population growth: increased income meant lower death rates, in some instances higher birth rates; and larger numbers either ate up the gain or, outstripping it, set the stage for Malthusian disaster. Even so, it seems clear that over the near-millennium from the year 1000 to the eighteenth century, income per head rose appreciably—perhaps tripled—and that this rise accelerated sharply in the eighteenth century, even before the introduction of the new industrial technology.

In a sense, this preparation alone is sufficient explanation of the European achievement: Europe industrialized because she was ready to; and she was the first to industrialize because she alone was ready to. But this kind of statement is merely an evasion of the issue; the question still remains, why Europe alone effected this advance.

A definitive answer is impossible. We are dealing here with the most complex kind of problem, one that involves numerous factors of variable weights working in changing combinations. This sort of thing is hard to deal with even if one has precise data that lend themselves to refined techniques of analysis. But we have almost no evidence of this kind for the pre-modern period (say, before the eighteenth century), so that any judgment must be based on an impressionistic examination of the record. Such a judgment is necessarily personal: it would be hard, I think, to find two historians who would agree across the board on the 'causes' of the European economic advance. Still, one man's interpretation can serve to guide or sharpen the appreciation of others, if only on an adversary basis. The analysis that follows, therefore, is my own—though it rests heavily on the work of those specialists whose arguments on particular points I have found persuasive. The method of inquiry is to seek out these factors of European development that seem to be both significant and different; that set Europe apart, in other

words, from the rest of the world. By holding Europe up against the mirror of the most advanced non-European societies, we should be able to discern some—surely not all—of the critical elements in her economic and technological precedence.

From this point of view two particularities seem to me to be salient: the scope and effectiveness of private enterprise; and the high value placed on the rational manipulation of the human and material environment.

The role of private economic enterprise in the West is perhaps unique: more than any other factor, it made the modern world. It was primarily the rise of trade that dissolved the subsistence economy of the medieval manor and generated the cities and towns that became the political and cultural, as well as economic, nodes of the new society. And it was the new men of commerce, banking, and industry who provided the increment of resources that financed the ambitions of the rulers and statesmen who invented the polity of the nation-state. Business, in other words, made kings—figuratively; and literally in the case of the Medici, who ruled Florence and whose children sat on the throne of France.

To be sure, kings could, and did, make or break the men of business; but the power of the sovereign was constrained by the requirements of state (money was the sinews of war) and international competition. Capitalists could take their wealth and enterprise elsewhere; and even if they could not leave, the capitalists of other realms would not be slow to profit from their discomfiture.

Because of this crucial role as midwife and instrument of power *in a context of multiple, competing polities* (the contrast is with the all-encompassing empires of the Orient or of the Ancient World), private enterprise in the West possessed a social and political vitality without precedent or counterpart. This varied, needless to say, from one part of Europe to another, depending on comparative economic advantage, historical experience, and the circumstances of the moment. Some countries were better endowed by nature for industry and trade than others. Some—especially those on the turbulent frontier of European civilization—came to accord inordinate place and prestige to the military and its values. And sometimes, adventitious events like war or a change of sovereign produced a major alteration in the circumstances of the business classes. On balance, however, the place of private enterprise was secure and improving with time; and this is apparent in the institutional arrangements that governed the getting and spending of wealth.

Take the idea and nature of property. This was often hedged around in the pre-industrial period by restrictions on use and disposition and by complications of title. Land especially was caught up in a thicket of con-

flicting rights of alienation and usufruct, formal and customary, which were a powerful obstacle to productive exploitation. Over time, however, the nations of western Europe saw an increasing proportion of the national wealth take the form of full property—full in the sense that the various components of ownership were united in the person or persons of the possessor, who could use the object of ownership and dispose of it as he saw fit.

Concomitant with this development and, indeed, implicit in it was the growing assurance of security in one's property—an indispensable condition of productive investment and the accumulation of wealth. This security had two dimensions: the relationship of the individual owner of property to the ruler; and the relationship of the members of the society to one another.

With respect to the first, the ruler abandoned, voluntarily or involuntarily, the right or practice of arbitary or indefinite disposition of the wealth of his subjects. The issue was joined very early, and its outcome was clearly linked to the larger question of the political as well as economic status of the business classes. Lambert of Hersfeld, an ecclesiastical chronicler of the eleventh century, tells the story of a confrontation on this score between the Archbishop of Cologne and the merchant community. The Archbishop wanted a boat for his friend and guest, the Bishop of Münster, and sent his men to commandeer a suitable vessel. The Archbishop may have been acting within his traditional rights; that is, the residents of Cologne may well have been obliged to furnish such facilities as a *corvée*. But in this instance, the son of the owner of the boat refused to submit and, calling some friends together, drove off the Archbishop's men-at-arms. The conflict quickly burgeoned into a riot, which the Archbishop finally succeeded in repressing by a show of force and threats of reprisal. Yet this was not the end of the matter:[1]

> ...the young man, who was filled with anger and drunk with his initial success, did not stop making all the trouble he could. He went about the town making speeches to the people about the bad government of the Archbishop, accusing him of imposing unjust charges on the people, of depriving innocent men of their property, and of insulting honorable citizens...It was not hard for him to arouse the populace...

This was surely not the last such incident at Cologne or elsewhere; but eventually the ruler learned that it was easier and in the long run more profitable to expropriate with indemnification rather than con-

[1] From the French of Jacques Le Goff, *La civilisation de l'Occident médiéval* (Paris, 1965), p. 368. I am indebted to my colleague Giles Constable for advice on the significance and credibility of this account.

fiscate, to take by law or judicial proceedings rather than by seizure. Above all, he came to rely on regular taxes at stipulated rates rather than on emergency exactions of indefinite amount. The revenue raised by the older method was almost surely less than that yielded by the new; over time, therefore, it constituted a smaller burden on the subject. But the effect of this uncertainty was to encourage concealment of wealth (hence discourage spending and promote hoarding) and to divert investment into those activities that lent themselves to this concealment. This seems to have been a particularly serious handicap to the economies of the great Asian empires and the Muslim states of the Middle East, where fines and extortions were not only a source of quick revenue but a means of social control—a device for curbing the pretensions of *nouveaux riches* and foreigners and blunting their challenge to the established power structure; and it was the experience of European traders in those countries that gave us from the Arabic the word 'avania' (French *avanie;* Italian *avania*), meaning both insult and exaction.[1]

At the same time—this is the second of our two dimensions—Europeans learned to deal with one another in matters of property on the basis of agreement rather than of force; and of contract between nominal equals rather than of personal bonds between superior and inferior. Jerome Blum, in his valuable study of Russian agrarian society, tells of one among many instances of violent seizure of land by a local lord from a nominally free peasant: the people in the area called the piece in question the 'cudgel field', because the servants of the rich man had beaten the poor farmer in public to exact his consent to the transfer.[2] (In most cases, of course, no beating would have been required; little men knew their place.) Predatory behaviour of this kind was easiest and most persistent in societies divided by wide barriers of power and status. Anywhere east of the Elbe, for example—in Prussia, Poland, Russia—the local lord enjoyed so much authority over the population that abusive treatment even of those residents who were nominally free,

[1] In these 'Oriental despotisms' one response to the threat of arbitrary levies was the investment of business profits in land, which had two major virtues in this respect: it was a fixed form of wealth, hence less tempting to covetous officials than liquid assets; and it sometimes conferred on its possessor political power, that is, a certain immunity from despoilment. Thus we find the richest business community of Safavid Persia, the Armenian silk merchants of Julfa, ready to risk their money in trading ventures as far afield as Poland and the Baltic, but hoarding it at home or using it to buy country estates. Amin Banani, 'The Social and Economic Structure of the Persian Empire in Its Heyday' (paper presented to the Colloquium in Middle Eastern Studies, Harvard University, 5 January 1968).

[2] Jerome Blum, *Lord and Peasant in Russia from the Ninth to the Nineteenth Century* (Princeton, 1961), p. 535.

let alone the unfree serfs, was widespread and unrestrainable. In these areas of seigneurial autonomy, moreover, conditions actually grew worse from the sixteenth to the eighteenth centuries, as the spread of commercial agriculture enhanced the incentive to exploit the weak.

In western Europe, however, the abuse of private power and recourse to violence were rarer and tended to diminish over time. (La Fontaine's *raison du plus fort* was reserved increasingly to international relations.) Here, too, the trend went back to the Middle Ages, when the ambitious rulers of inchoate nation-states succeeded in substituting their writ for that of their vassals; and in developing, as an instrument of royal power, a judicial apparatus operating in a context of established rules. They were helped in this effort by the bourgeoisie (in the strict sense of the citizens of the towns), who needed the protection of the law to flourish and, flourishing, provided the crown with a counterweight to the common feudal enemy.

The shift from diffuse obligations to explicit contract was part of the same development. Medieval society had been held together by loosely defined, open-ended personal bonds between lord and vassal, seigneur and serf; but business could not operate in this realm of indeterminacy and needed a measure for all things. The new law provided the measure, and the new nation-state enforced it.

These political and legal changes combined with economic and social developments to undermine seigneurial authority and enhance the personal status of the peasantry. Without attempting to examine this process in detail, one may point to a few major influences: the Black Death and subsequent epidemics, which altered sharply the ratio of land to labour and compelled the propertied classes to offer substantial inducements to attract and hold the manpower needed to work their estates; the long inflation of the sixteenth century, which found many peasants holding long-term leases whose burden diminished with the value of the currency; above all, the rise throughout western Europe of prosperous cities and towns, which offered refuge, employment and freedom to the serf who left the land and which thus acted as a constant source of upward pressure on the conditions of rural life. As a result, the opportunities created by a growing market for cash crops conduced not, as in the East, to the aggravation of labour services and a tightening of control, but to the solution of personal bonds and the substitution of free peasant enterprise for managed domains. This in turn laid the basis for what was to prove a crucial element in the rise of industrial capitalism: the spread of commercial manufacture from the towns to the countryside. It was this that enabled European industry to draw on an almost unlimited supply of cheap labour and to produce at a price that opened to it the markets of the world.

The rise of rural manufacture was the most striking and significant expression of freedom of enterprise; but one should not infer from the fact of this rise a state of generalized freedom. On the contrary, the very unevenness of this development—cottage production for market came far earlier in England than elsewhere—is testimony to the fierce and successful opposition it encountered from privileged interests in the towns; and these privileges are only one example of the many fetters on trade and industry. Thus essential commodities like food were subject to formal and customary restrictions designed to insure the nourishment and tranquillity of the population. Land, as noted above, was *sui generis:* because of its tie to social status and power, rights of purchase and alienation were often severely limited. Entrance into numerous occupations was subject to official authorization or to the permission of guilds that had every incentive to minimize competition by excluding newcomers. By the same token, the authorities often tried to confine business activity to fixed channels, to prohibit as unfair a wide range of what we would consider perfectly permissible behaviour, to discourage innovation that might harm vested interests. Much of this reflected the values of the medieval village or town community, which saw wealth as more or less fixed and assumed that the only way one got rich was at the expense of one's neighbour. Yet these constraints made little sense in a context of increasing wealth and rising productivity.

For all that, the scope of private economic activity was far larger in western Europe that in other parts of the world and grew as the economy itself grew and opened new areas of enterprise untrammelled by rule or custom. The trend was self-reinforcing: those economies grew fastest that were freest. This is not to imply that state enterprise or control is intrinsically inferior to private enterprise; simply that, given the state of knowledge in pre-industrial Europe, the private sector was in a better position to judge economic opportunity and allocate resources efficiently. Even more important, perhaps, was the impulse given thereby to innovation: in an age when the nature and direction of technological opportunity were far less obvious than now, the multiplication of points of creativity was a great advantage. The more persons who sought new and better ways of doing things, the greater the likelihood of finding them. Again the process was self-reinforcing: those economies that were freest seem to have been most creative; creativity promoted growth; and growth provided opportunities for further innovation, intended or accidental.

Why the rest of the world failed to develop a business class of comparable vitality and influence is still more a matter for speculation than analysis. The explanations offered by the specialists are not fully per-

suasive; often they take the form of bald assertions of cause-and-effect without specification of the intervening mechanism of change. Thus Prof. Wu Ta-k'un tells us that the establishment in China of a state monopoly of salt and metals (Han dynasty, 206 B.C. to A.D. 220) 'effectively checked the development of a mercantile class separate from the land-owning interest'. Perhaps; though one is more impressed by his reference to the congruency of the administrative and landowning elites and the assimilation of successful merchants into this group. 'For this reason,' he writes, 'the development of merchant capital led, not to the formation of a capitalist class, but to the continuous reinforcement of the landowning ruling class.'[1]

These and similar explanations are the ones usually offered for the abortion of economic development in non-European societies. Sometimes the historian stresses the subordination of trade and traders to an all-powerful central authority; sometimes the social inferiority and disabilities of the merchant class; sometimes the precarious character of private property and the heavy burden of arbitrary exactions; sometimes all of these. None of these was wholly absent in Europe; but the usual argument is that the differences in degree were so great as to be differences in kind. Where, for example, in Europe does one find anything comparable to the Egyptian principle that all wealth is the property of the ruler, lent by him to his subjects and taxable or confiscable at will?

In any event, it was surely one of Europe's great advantages that its first capitalist entrepreneurs worked and flourished in autonomous city-states, hence political units where the influence of landed wealth was necessarily limited; and that even in the larger embryonic nation-states, the special juridical status of the urban commune made it possible for its inhabitants to develop and sustain their own distinct political interest, while it isolated them culturally and socially from the great agrarian world around them. In this way the cities were not only foci of economic activity but schools of political and social association—

[1] Wu Ta-k'un, 'An Interpretation of Chinese Economic History', *Past and Present*, no. 1 (1952), pp. 6, 9. Cf. Frederic Wakeman, Jr., *Strangers at the Gate: Social Disorder in South China, 1839–1861* (Berkeley and Los Angeles, 1966), p. 45: 'But Chinese society was bureaucratic, state-centered. Tax-farming or monopoly capitalism was the only sure road to wealth. Instead of being an independent, vigorous class that challenged a ruling aristocracy, the Cantonese merchants lived in symbiosis with the state and its mandarinate. Status honor being what it was, wealth invariably led to the purchase of office, or conspicuous consumption in the scholar-gentry manner, both of which dissipated capital. Thus the merchants of China were perpetually servile to the honored symbols of that society, the gentry.' For similar tendencies in the Mameluke Empire of Egypt and Syria during the fifteenth century, see Ira M. Lapidus, *Muslim Cities in the Later Middle Ages* (Cambridge, Mass., 1967), p. 126.

incubators of the bourgeoisie as a self-conscious, assertive interest group. They were also crucibles for the refinement of values that, although profoundly rooted in European culture, were still deviant and limited to a minority—values ultimately subversive of the feudal order.

This brings us to what I suggested was the second of Europe's salient particularities: the high value placed on the rational manipulation of the environment. This in turn may be decomposed into two elements: rationality, and what we may call the Faustian sense of mastery over man and nature. (Such decomposition does violence to the historical reality, for the two are intertwined; but it is useful for purposes of analysis.)

Rationality may be defined as the adaptation of means to ends. It is the antithesis of superstition and magic. For this history, the relevant ends are the production and acquisition of material wealth. It goes without saying that these are not man's highest ends; and that rationality is not confined to the economic sphere. But whatever the area of activity, the means-end criterion holds; besides, there is good reason to believe that rationality is a homogeneous character trait, that is, that he who is rational in one area is more likely to be rational in others.[1]

The story of rationality as value and way of life has yet to be written, although a number of social scientists, notably Max Weber, have expatiated on its significance for the course of Western development. It shows up earliest perhaps in the sphere of religion, where one finds a strong tendency in the Judaic tradition to eliminate magic and superstition as a senseless degradation of faith. To be sure, this catharsis was never complete, and the rise of Christianity introduced a new emphasis on the instinctual and emotional aspects of faith and action. Yet the rational tradition remained powerful and found expression in the invention of a calculus of salvation and in the elaboration of codes and techniques for the management of the material possessions of the Church.

To what extent the Church was motivated here by internal values and to what extent by the values of secular society, is hard to say. Clearly the place of magic and superstition in Christian worship has always varied markedly from one part of Europe to another; and indeed much of the Church's effectiveness in proselytization has stemmed from its readiness to find compromises between an austere orthodoxy and

[1] Rationality in this sense should be distinguished from rationalism, which is the doctrine or principle that the universe of perception and experience can be understood in terms of thought or reason, as against emotion, intuition, or extra-sensory modes of apprehension. Rationality is thus a way of doing things, the application of the principles of rationalism to action. It is quite possible to behave rationally, however, in the sense of adapting means to ends, without explicit or conscious adherence to the doctrines of rationalism; that is, one does not have to be a philosopher to act rationally.

the ways of indigenous paganism. Yet there is good reason to believe that already in the Middle Ages, Europe was freer of superstition and more rational in behaviour than other parts of the world.

How does one know this? We have no measures. But there is one indicator that may be a valid surrogate, and that is population control. European birth rates before industrialization were well below the biological maximum—significantly lower, for example, than the rates of today's pre-industrial societies before and even after the introduction of programmes of family planning. Moreover, in so far as there were variations in birth rates—and they range from 55 to 60 per thousand in colonial America and French Canada to 15 per thousand in Iceland at the beginning of the eighteenth century—they seem to have been closely related to the ratio of resources to population.[1] This is evidence presumably of self-restraint—an effort to restrict commitments to means—and as such is an excellent example of rationality in a particularly crucial and sensitive area of life.[2]

It is against this background that one can best appreciate the significance of the so-called Protestant ethic for the development of European capitalism. The reference, of course, is to the work of Max Weber, who first advanced the hypothesis that the rise of Protestantism, particularly in its Calvinist version, was a major factor (not the only factor) in the creation of a modern industrial economy in western Europe. Weber was not the first to observe a link between Protestant belief and economic advance; already in the seventeenth century, observers were struck by the apparent congruency of the Reformed faith and business success. But Weber offered a new and coherent explanation for the link in terms, not of the content of Protestant doctrine, but of the pattern of behaviour inculcated by Protestantism on its adherents.

Hence the emphasis on ethics, that is, a set of values governing everyday conduct. In brief, Weber argued that the Calvinist doctrine of predestination instilled in its believers a deep anxiety about their salvation that could be appeased only by leading the kind of life that those

[1] John T. Krause, 'Some neglected factors in the English Industrial Revolution', *Journal of Economic History*, XIX (1959), 528–40. Demographic research has shown, however, that the Asian peasant who has as many children as possible is following a rationality of his own: given the high mortality, numbers are a kind of guarantee against a childless old age; they are the equivalent of an insurance policy. Yet this merely displaces the question. Mortality rates were presumably just as high in western Europe in the pre-industrial period as in contemporary Asia. Why did the European peasant not feel this need? The answer may lie in better arrangements for mutual support in time of need—group insurance, as it were, instead of family insurance. The problem is much too complex and little known for us to explore here.

[2] Professor Henry Rosovsky tells me that there is good evidence of fertility control in pre-industrial Japan as well.

destined for salvation might be expected to lead; and that this life was one of in-the-world asceticism (as opposed to the monastic asceticism of the Catholic Church)—a life in which one's time and energies were devoted exclusively to those worthy activities (prayer and work) that conduced to the glory of God. Such a standard, argued Weber, was obviously also conducive to the accumulation of wealth: the good Calvinist was diligent, thrifty, honest, austere. Moreover this way of life, originally rooted in religious doctrine, came to have a force of its own: it became important to live this way, not because it provided assurance of probable salvation, but because this was the right way to live. In short, the means had become end. So that even after the first surge of Protestant zeal had subsided, the ethic remained; and such new Protestant sects as made their appearance in subsequent centuries—Pietism, Quakerism, Baptism, Methodism—incorporated these standards of behaviour in their moral codes.

Few historical arguments have aroused so much controversy as the so-called Weber thesis; there is a library on the subject, and the debate still rages. Most of the objections follow one or more of three lines: (1) It was not Protestantism that promoted capitalism, but the reverse: pushful, hard-working, successful businessmen sought moral sanction for their way of life and their gains and found it in Protestantism. (2) The superior performance of certain Protestant business communities may be explained, not by their religion, but by their status as persecuted minorities. Deprived of the opportunity to enter established universities or pursue respected careers in the liberal professions or state service, they turned to business, where they worked harder and better than their competitors, the more so as their cohesion and mutual support gave them an advantage over outsiders. (3) There is no empirical link between Protestantism and business success.

The last of these may be dismissed out of hand; it has been advanced by some reputable scholars, but it is simply erroneous, as any examination of the British, French, or German record makes clear. The other two objections are more serious, though they are not necessarily incompatible with the Weber thesis. It is quite reasonable to argue, for example, that the Protestant ethic constituted religious sanction for an already established pattern of behaviour and still attribute considerable influence to it as a support for and propagator of this pattern in the face of competitive value systems. And by the same token, positive religious or ethical standards may well have reinforced the negative stimulus to performance provided by minority status.

Still, this is much too complex and embroiled a question to resolve here. What is important for this analysis is the significance of the Calvinist ethic, whatever its source, as an extreme example of the ap-

plication of rationality to life. The insistence on the value of time, the condemnation and abhorrence of pleasure and diversion—all those censorious prohibitions and internalized inhibitions that we denote as puritanism with a small *p*—were more than a new version of the appetite for wealth. They constituted in effect an imposition of the criterion of efficiency on every activity, whether or not directly connected with getting and spending.

The complement of this spirit of rationality was what we may call the Faustian ethic, the sense of mastery over nature and things. The one reinforced the other: mastery entailed an adaptation of means to ends; and attention to means and ends was the precondition of mastery. The theme is an old one in Western culture, going back to the myths of Daedalus and Prometheus, or even to the stories of the Tower of Babel and of Eve, the serpent, and the tree of knowledge (knowledge is mastery). The ancients were dreadfully afraid of this emulation of the gods, and not coincidentally the protagonists in each case were punished for their *hubris*. For similar reasons, the Christian Church, itself heir to both the Judaic and Greek traditions, repeatedly condemned as heresy those doctrines—Pelagian and pseudo-Pelagian—that magnified man's natural ability and, explicitly or implicitly, denied his dependence on God for grace and the Church for salvation. There remains a strong current in popular Christianity that condemns certain acts of technological prowess as assaults on the divine order: if God had intended man to fly, he'd have given him wings.

On the other hand, the very reiteration of this theme is evidence of the persistence of the aspiration towards mastery of the environment; and indeed some would argue that the Church itself contributed unwittingly to the heresy by its sanctification of work and its opposition to animism. So long as every tree had its dryad and every fountain or stream its naiad, man was intimidated and inhibited in his confrontation with nature. But when, writes Lynn White, 'saint replaced animistic sprite as the most frequent and intimate object of popular religious concern, our race's earthly monopoly on "spirit" was confirmed, and man was liberated to exploit nature as he wished. The cult of saints smashed animism and provided the cornerstone for the naturalistic (but not necessarily irreligious) view of the world which is essential to a highly developed technology.'[1]

Be that as it may, it is clear that the urge to mastery grew with time

[1] Lynn White, Jr., 'What Accelerated Technological Progress in the Western Middle Ages?', in A. C. Crombie, ed., *Scientific Change* (New York, 1963), p. 283. (I owe this reference to Prof. Nathan Rosenberg.) Cf. the observations of Jacques Le Goff on the desacralization of nature in Gothic art. *La Civilisation de l'Occident médiéval*, p. 435.

and fed on success, for every achievement was justification for the pretension; while the moral force of the Church's opposition waned with its temporal power and its own growing insecurity in the face of a triumphant materialism. Even more important, perhaps, was the scientific revolution of the early modern period, which not only upset specific articles of religious faith but implicitly discredited all traditional wisdom and authority. Science indeed was the perfect bridge between rationality and mastery: it was the application of reason to the understanding of natural and, with time, human phenomena; and it made possible a more effective response to or manipulation of the natural and human environment.

More than that: it was precisely the applicability of scientific knowledge to the environment that was the test of its validity. The mode of perception and thought that we know as science was not, and is not, the only such mode. Certain Asian societies in particular have devoted considerable effort to the exploration of a world that lies outside or beyond the material universe accessible to ordinary sensory cognition. This other world may lie within or without the observer, who enters it usually with the assistance of drugs or through the medium of a deliberately induced trance-like state. Sometimes the claim is made that this is a higher form of consciousness; sometimes, merely that this other world is another, rich realm of a larger universe of experience. In either case, the assumption is that this, too, is real.

Western societies have also had their exploration of other realms, with or without drugs—their religious ecstasies, magical rites, superstitions, fairy tales, daydreams. But Western societies, and more particularly their intellectual and scientific leadership, established very early the boundary line between fantasy and reality, drawing careful distinctions between spiritual and material, between the realm of emotion and imagination on the one hand and that of observation and reason on the other. The shibboleth has been the communicability of experience: something is real if it can and will be perceived and described, perhaps even measured, by any person with the requisite faculties and instruments in the same terms.[1] In other words, what you see, I see.

This communicability of experience is the basis of scientific and tech-

[1] To be sure, any such definition of reality would seem to exclude a whole world of abstract phenomena, no less actual and significant for their abstractness and inscrutability. One thinks of the common coin of the social sciences—concepts like nationalism, imperialism, class consciousness, and the like. With these and most other ideational constructs, it is hard to achieve agreement on specific instances, let alone on general definitions. Nevertheless here too the criterion of reality remains communicability of experience, and in so far as the social sciences have not satisfied this criterion, they have lagged behind the natural sciences in understanding and control (for better or worse) of their subject matter.

nological advance, because it makes possible the transmission and cumulation of knowledge. The stuff of a dream is evanescent; the perceptions of a 'religious experience' are highly personal. These transcendental impressions may leave a legacy of emotions, attitudes, values. What they do not yield is cognitive building blocks. By carefully distinguishing between these two forms of knowledge, Western culture saved itself from material impotence, at the cost perhaps of a certain psychic impoverishment. (I say 'perhaps' because those who have not enjoyed transcendental experiences must take those who have at their word.)

The same point can be made about the highly complex and abstract reasoning of certain 'primitive' societies—reasoning that anthropologists are currently much concerned with and that they find to be different from, but not necessarily inferior to, the rationalism of science. This ethnological literature is curiously defensive: by stressing the profundity and intimacy of these other systems of thought, by minimizing the differences, for example, between science and magic, the savant seeks to elevate the 'savage' to intellectual as well as spiritual and moral parity with the '*civilisé*'.[1] The cause is a worthy one. The anthropologist here has assumed the mantle of the priest who preaches humility by depreciating the works of man; and the humility of the twentieth century is relativism.

Yet although modesty is good for the soul, it is not always true. The difference between science and magic is the difference between rational and irrational; that is, the one makes possible effective action and the other does not, except adventitiously. 'It may be objected,' writes Lévi-Strauss, 'that science of this kind [that is, primitive thought] can scarcely be of much practical effect. The answer to this is that its main purpose is not a practical one. It meets intellectual requirements rather than or instead of satisfying needs' (p. 9). The answer is valid on the level of humanistic appreciation; it is irrelevant on the level of performance.

And it was primarily performance that was the criterion of the interest and validity of scientific inquiry in these first crucial centuries of intellectual exploration (as opposed to the medieval mastication of traditional wisdom). The performance in question was the production of wealth—hence the alchemist's obsession with the conversion of base substances into gold; the achievement of eternal youth; or the enhancement of power—hence the preoccupation with the laws of motion and trajectory (needed for effective use of artillery), the principles of hydraulics (of interest to builders of ports and canals), the chemistry of explosives (useful in the production of armaments), and similar problems.

As the reader will have noted, some of the above goals were in fact unattainable; much of this early science was still tinged with magic.

[1] Thus Claude Lévi-Strauss, *The Savage Mind* (Chicago, 1966), pp. 8–11.

Even so brilliant a scientist as Isaac Newton, the heir of a century of intellectual revolution, was credulous on this score. In his famous letter of 1669 (he was then only 26) to Francis Aston, advising that young man how to make the most of his travels, he suggests that Aston inquire whether 'in Hungary... they change Iron into Copper by dissolving it into a Vitriolate water wch they find in cavitys of rocks in the mines & then melting the slymy solution in a strong fire...'[1]

Yet it would be a mistake to equate this credulity with superstition. Rather, this kind of alchemy represented in effect a transitional stage between magic and science, between the irrational and the rational, in the sense that the change sought was to be accomplished by a real agent, and not by patently immaterial incantations. Newton did not know enough chemistry to realize that the kind of mutation he envisaged was impossible. But he and his contemporaries knew enough about the nature of reality and were sufficiently pragmatic to insist on results; so that when all the alchemical ingenuity in the world failed to turn up the philosophers' stone or the elixir of life, they abandoned the search and turned their knowledge and skills to the rational accomplishment of feasible ends. And so alchemy became chemistry.

The significance of Newton's letter, however, lies not in its instance of cultural lag, but in its theme, which is one of pervasive curiosity. Don't waste a moment, it says; come back with all the knowledge you can acquire. And Newton actually offers his friend a set of rules that will enable him to maximize the intellectual return to travel—among others: 'let your discours bee more in Quaerys & doubtings yn peremptory assertions or disputings, it being ye designe of Travellers to learne not teach...' The Europeans of the Middle Ages, and even more their children, were inveterate learners—above all, in technology. To be sure, the history of cultural diffusion in the pre-modern period is obscure; the specialists in the field rely heavily on discrete, ambiguous iconographic materials and treacherous philological evidence. Even so, it seems clear that Europe imported from the East over a period of centuries a whole array of valuable and sometimes fundamental techniques: the stirrup, the wheelbarrow, the crank (to convert reciprocal to rotary motion), gunpowder, the compass, paper and, very likely, printing. Many of these came originally from China, which enjoyed at various times during the T'ang (618–907) and Sung (960–1279) dynasties the most advanced technology and economic organization in the world.[2]

[1] H. W. Turnbull, ed., *The Correspondence of Isaac Newton*, vol. I: *1661–1675* (Cambridge, 1959), pp. 9–11.

[2] The students of the subject are not always in agreement which innovations Europe imported from the Orient, which ones it developed independently, which ones both

This readiness and even eagerness to learn from others, including other Europeans—industrial espionage is a theme running all through modern European history—was testimony to an already thriving indigenous technology; good innovators make good imitators. It was also a great advantage for the nascent capitalist economy, the more so as other societies were less enterprising in this regard. The Chinese, for example, were wont to look at the rest of the world as a barbarian wasteland, with nothing to offer but tribute; and even the obvious lead of Western technology in the modern period was insufficient to disabuse them of this crippling self-sufficiency.[1] On the contrary, their contacts with Europeans in the eighteenth and early nineteenth centuries only confirmed their belief in their own superiority and enhanced the xenophobic component: the foreigners were dangerous animals—lewd, greedy, ignorant; and the Chinese who dealt with them always ran the risk of being denounced, or worse, as a traitor.[2] So that where the Japanese responded with alacrity and success to the technological and political challenge of the West, the Chinese vacillated between disdainful rejection and reluctant, constrained imitation and fell between the two stools.

In the Muslim world, it was religious rather than national or ethnic pride that posed an obstacle to the importation of knowledge from outside. From the start, Islamic culture was at best anxiously tolerant of scientific or philosophical speculation—partly because it might divert the attention of the faithful from their obligatory concern with God, his revelation, and the prophetic tradition; partly because profane thought might shake belief. Certain fields of inquiry were legitimate because they obviously contributed to the well-being of the community: medicine, a modicum of mathematics and astronomy (needed to determine the religious calendar), geography (needed for administration), and the theory of administration itself. This is the way von Grunebaum sees the problem:

> But anything that goes beyond these manifest (and religiously justifiable) needs can, and in fact ought to, be dispensed with. No matter how important the contribution Muslim scholars were able to make to the natural sciences,

derived from a common source, and so on; but this absence of consensus is not surprising in view of the character of the evidence. See on this subject, *inter alia*, Lynn White, Jr., *Medieval Technology and Social Change* (Oxford, 1962), and J. Needham, 'L'unité de la science: l'apport indispensable de l'Asie', *Archives internationales d'histoire des sciences*, no. 7 [*Archeion*, nouv. série, XXVIII] (April, 1949), pp. 563–82 (the latter inclined perhaps to overstress the Asian contribution).

[1] Cf. John K. Fairbank *et al.*, 'The Influence of Modern Western Science and Technology on Japan and China', in Comitato Internazionale di Scienze Storiche, X Congresso Internazionale di Scienze Storiche, Roma 4–11 Settembre 1955, *Relazioni*, vol. v: *Storia contemporanea* (Florence, n.d.), pp. 243–69, esp. pp. 254–6.

[2] Cf. Wakeman, *Strangers at the Gate*, ch. iv: 'Traitor in Our Midst'.

and no matter how great the interest with which, at certain periods, the leading classes and the government itself followed and supported their researches, those sciences (and their technological application) had no root in the fundamental needs and aspirations of their civilization. Those accomplishments of Islamic mathematical and medical science which continue to compel our admiration were developed in areas and in periods where the elites were willing to go beyond and possibly against the basic strains of orthodox thought and feeling. For the sciences never did shed the suspicion of bordering on the impious which, to the strict, would be near-identical with the religiously uncalled-for. This is why the pursuit of the natural sciences as that of philosophy tended to become located in relatively small and esoteric circles and why but few of their representatives would escape occasional uneasiness with regard to the moral implications of their endeavors—a mood which not infrequently did result in some kind of an apology for their work. It is not so much the constant struggle which their representatives found themselves involved in against the apprehensive skepticism of the orthodox which in the end smothered the progress of their work; rather it was the fact, which became more and more obvious, that their researches had nothing to give to their community which this community could accept as an essential enrichment of their lives. When in the later Middle Ages scientific endeavor in certain fields very nearly died down, the loss did indeed impoverish Muslim civilization as we view its total unfolding and measure its contribution against that of its companion civilizations, but it did not affect the livability of the correct life and thus did not impoverish or frustrate the objectives of the community's existence as traditionally experienced.[1]

As von Grunebaum's analysis makes clear, the effect of this suspicion and hostility was to isolate the scientific community, place its representatives in an apologetically defensive posture, and render difficult, if not impossible, the kind of triumphant cumulative advance that was to occur in the West some hundreds of years later. Even so, the achievements of Muslim science were substantial, and it was through Arabic translations that the classics of Greek science were transmitted to late medieval Europe. In those days, Europe was the backward country, and Islam, the advanced exporter of knowledge. What caused Muslim science to vegetate just at the time when Western science was reawakening? And why did knowledge not flow the other way once the balance of achievement had shifted?

The answer seems to be that the latent anti-intellectual values of the culture triumphed, in large part owing to the same kind of physical disaster that had overwhelmed the Roman Empire and set European science back almost a thousand years. For Islam too, it was a series of invaders—the Banu-Hilāl in North Africa; the Crusaders in Syria,

[1] G. E. von Grunebaum, *Islam: Essays in the Nature and Growth of a Cultural Tradition* (2nd ed., London, 1961), p. 114.

Palestine, and Egypt; above all, the waves of nomads from the Asian steppe, culminating in the terrifying Mongol hordes of the thirteenth century—that brought the classical civilization down. The political fabric was rent; the urban centres were sacked; the indispensable capital base of the society, the irrigation works, left in ruins. The Dark Ages that followed saw a revival of know-nothing mysticism and a reversion to uncompromising religious fundamentalism. Islam turned in on itself and found its own kind of peace in spiritual self-sufficiency: 'The Muslim's world is at rest, and he is at rest within it, and what strikes us as decadence, is to him repose in the bosom of eternal truth.'[1]

The obscurantist influence of Islam was the stronger for two considerations that distinguished sharply East and West. The first was the all-pervasive role of the Muslim religion, which reigned sovereign even in those spheres that had long been reserved in the West to secular authorities. The dichotomy between Caesar and God was never established in Islam, perhaps because the Muslim people (the *'umma*) and their world were a creation of the faith, whereas Christianity had had to make a place for itself in the powerful Roman state. There was, in other words, no legitimate source of sanction and authority in Islam outside the teachings of the Prophet and the lessons derived therefrom.

Secondly, the unity of Islam in the matter of intellectual inquiry worked against the success of deviant patterns of thought or behaviour. Not that Islam did not have its schisms and heresies. Almost from the start the faith was split into Sunnite and Shi'ite camps, and these in turn generated their own subdivisions. These sectarian movements, however, almost invariably embodied deviations to the 'right', in the direction of mysticism, devotionalism, more rigorous observance. Throughout the doctrinal spectrum, therefore, there prevailed a spiritual orthodoxy at best unfavourable, at worst hostile to scientific endeavour.

The pragmatic creativity of European science, like the vitality of the European business community, was linked to the separation of spiritual and temporal and to the fragmentation of power within each of these realms. Thanks to the Protestant revolt, there could be no peremptory orthodoxy in Europe like the *Shari'a* of Islam. Not that Protestants could not be as dogmatic as Catholics. But they were sectarians, and what is more, sectarians in a world that had not known serious religious division. There had been, to be sure, conflicts over the papal succession; but these were political rather than religious. There had also been eccentric heresies like that of the Cathars; but these had been confined in space and time and had not inflicted lasting damage on the Catholic edifice. The Reformation, on the other hand, effected the first signifi-

[1] J. J. Saunders, 'The Problem of Islamic Decadence', *Journal of World History*, VII (1963), 719.

cant rupture of Western Christianity since the suppression of the Arian heresy almost a thousand years before. The very existence of unsubmissive and unsuppressable Protestant sects was implicit justification for disobedience and schism.

Even more important, perhaps, was the content of the protest: the stress on personal faith and the primacy of conscience carried with it the seeds of unlimited dissent. These seeds did not always flower: witness the authority that Luther accorded the temporal power; or the conservative bias of English Methodism. Still, the principle was there, potent even in quiescence; and it came to serve as cover not only for religious nonconformity but for secular speculation. It was not hard to make the jump from one sphere to the other: if people were to let their conscience be their guide in matters of faith, why not let their intelligence be their guide in matters of knowledge? The result was far greater opportunity for scientific inquiry. In addition, more positive stimuli may well have played a role: a generation ago Robert Merton argued in a seminal monograph on *Science, Technology, and Society in Seventeenth Century England* that it was the ethical content of early Protestantism that accounted for the disproportionate achievement of Dissenter scientists; and this argument has been extended by inference to explain the larger shift of the intellectual centre of gravity from Italy to northern Europe.[1] Yet surely the other side of the coin is equally important, namely, the stultifying effect of the counter-Reformation on freedom of thought and investigation in Catholic lands.[2]

By the same token, European science and technology derived considerable advantage from the fact that the continent was divided into nation-states, rather than united under the rule of an ecumenical empire. Fragmentation, as we have seen, entailed competition, specifically competition among equals. In this contest, science was an asset of state, not only because it furnished new tools and improved techniques of war, but because it contributed directly and indirectly to the general prosperity, and prosperity contributed to power. This was true not only of natural science, but also of what has since come to be known as social science: one of the principal incentives to the analysis of social action was the pursuit of power.

Hence mercantilism. The state acted, controlling and manipulating

[1] Published originally in *Osiris: Studies on the History and Philosophy of Science, and on the History of Learning and Culture*, IV, part II (Bruges, 1938). The Merton thesis has given rise to considerable debate, which is as lively today as ever, in spite of urgings from opponents that the argument be laid to rest. See especially the exchanges in *Past and Present*, in particular, nos. 28 and 31.

[2] Cf. H. R. Trevor-Roper, *Religion, the Reformation and Social Change* (London, 1967), p. 42, n. 1; John Elliott, 'The Decline of Spain', *Past and Present*, no. 20 (November, 1961), p. 68.

the economy for its own advantage, and theory hastened to follow. (In this respect too, mercantilist thought and natural science had much in common: throughout this period and indeed well into the nineteenth century, theoretical science was in large measure devoted to understanding the achievements of technology.) The theory in turn provided man with new tools for mastery of his environment. Admittedly, mercantilist doctrine was shapeless, inconsistent. It was inconsistent because it reflected policy as much as guided it, and each state did with its economy what circumstances warranted, knowledge (or ignorance) suggested, and means permitted. Mercantilism was, in short, pragmatism gilded by principle.

Yet mercantilism was more than mere rationalization. Precisely because it was pragmatic, because it aimed at results, it contained the seeds of the sciences of human behaviour. Its principles were modelled on those propounded for the natural sciences: the careful accumulation of data, the use of inductive reasoning, the pursuit of the economical explanation, the effort to find a surrogate for the replicated experiment by the use of explicit international comparisons. Moreover, in this early modern period it was quite common for the natural scientist to interest himself in this realm of social behaviour. In the above-quoted letter from Newton to Aston, the first suggestions Newton makes are the following:

> 1 to observe ye policys wealth & state affaires of nations so far as a solitary Traveller may conveniently doe. 2 Their impositions upon all sorts of People Trades or commoditys yt are remarkeable. 3 Their Laws & Customes how far they differ from ours. 4 Their Trades & Arts wherin they excell or come short of us in England.

The preceding discussion is not intended to imply that mercantilism was uniformly promotive of European economic development; or even that it was so on balance. On the contrary, we know that it was often misdirected (just as certain efforts in the domain of natural science and technology were misdirected), and we shall have to consider later the effects of this misdirection on the timing and character of industrialization within Europe. Our point here is simply that mercantilism was the expression in the sphere of political economy—a particularly striking expression—of the rationality principle and the Faustian spirit of mastery. This is why it could generate a continuing flow of knowledge and outgrow the political circumstances that gave it birth. Because it was built on the same cognitive basis as natural science, because it accepted the criterion of performance, it was the initial stimulus to the collection of economic and social statistics and the forerunner of the whole range of economic theory, from *laissez-faire* to socialism.

All of this gave Europe a tremendous advantage in the invention and adoption of new technology. The will to mastery, the rational approach to problems that we call the scientific method, the competition for wealth and power—together these broke down the resistance of inherited ways and made of change a positive good. Nothing—not pride, nor honour, nor authority, nor credulity—could stand in the face of these new values. Not pride nor honour: the important thing, Newton wrote Aston, is 'to learne not teach'. Do not be umbrageous, he warns. If you find yourself insulted, let it pass; no one will know about it in England. Lack of forbearance, even under provocation, may pass among friends; among strangers, it 'only argue[s] a Travellers weaknesse'. Nor authority: Descartes' first principle of method 'was never to accept anything for true which I did not clearly know to be such; that is to say, carefully to avoid precipitancy and prejudice'. Nor credulity: Newton's fourth rule of reasoning stated that once one has induced the truth from empirical evidence, one should stick by it and not imagine or accept contrary hypotheses until there is hard evidence to support them.

These, it seems to me, are the crucial values of that European culture and society that gave birth to the modern industrial world: rationality in means and activist, as against quietist, ends. But these alone will not account for the entire discrepancy between Western economic development and that of the leading centres of civilization elsewhere. There was also the element of differential violence—violence, first, in the sense of destructive incursions; and second, in the sense of dominion and exploitation of one society by another.

Western Europe had known more than its share of the first in the late Roman Empire and Middle Ages; indeed the central institutions of medieval society—the personal subordination, the striving for self-sufficiency, the decentralization of authority—were all primarily responses to physical danger and insecure communications. But from the eleventh century on, the pressure of invasion diminished: the Norsemen settled in their new homes and became domesticated; the Hungarians did the same; the Saracens withdrew and confined themselves to desultory raids. Instead, Europe began thrusting outward—into Slavic lands to the east and Muslim countries in the Levant and to the south. From this time on, it expanded almost without interruption or setback; and with the exception of eastern Europe, which suffered periodically from the incursions of nomads from the Eurasian steppe and lost the Balkan peninsula to the Ottoman Turk, the continent was spared the death and ruin of outside aggression. To be sure, Europe was not free of war: one thinks of the intermittent Hundred Years' War between England and France; the civil and religious conflicts of the

fifteenth and sixteenth centuries; worst of all, the disastrous Thirty Years' War (1618–48), which laid waste large areas of central Europe by fire, the sword, and disease, to the point where some districts lost five-sixths of their population by death and flight and took a century to recover. But now the only enemy that Europeans had to fear was other Europeans; and as the conflicting ambitions of the different nation states worked themselves out in the form of a more stable balance of power, the virulence of the fighting diminished, particularly in that north-western corner of Europe that had taken the lead in economic development.

Other areas were perhaps less fortunate. Certainly the Muslim world suffered blows far heavier than those inflicted on western Europe: the Mongol invasions of the thirteenth century were followed in the late fourteenth by the conquests of Timur, who ranged from Anatolia in the West to India in the East and marked his victories with minarets and pyramids of skulls—a monument to his power and a warning to the survivors. Timur in turn was followed by lesser Turkoman warlords, some of whom fought their way briefly on to the stage of history and then disappeared, while others established dynasties of varying durability in the successor states of the once mighty Mongol empire. As a result of this dissolution, the Muslim world found a new, though far from stable equilibrium in a division between Persian and Mogul East and Turkish–Arabic West. For more than two hundred years, from the early sixteenth century on, the Ottomans and the Safavid Persians waged intermittent war, addressing themselves the while to occasional bouts with other adversaries: nomads from the steppe, Russians spreading southward and eastward, the Afghan tribes and Mogul emperors to the east, the nations of Christian Europe in the Danube valley and the Mediterranean. The land was forever criss-crossed with armies; siege followed siege, massacre followed massacre. Even the ghastliest carnages of the Thirty Years' War—the sack of Magdeburg for example—pale alongside the bloodbaths of Delhi. The record of shifting dynasties, palace plots, reigns of terror, and mad rulers reads like an Oriental version of the Merovingian snakepit.

Meanwhile the growing technological superiority of the West enabled the European nations to impose their dominion on the most distant lands, sometimes on the basis of formal annexation and colonization of territory, sometimes by means of an informal commercial tie with weaker peoples. The story of this overseas expansion is too well known to require review here; but it is of interest to us to inquire what contribution imperialism made to the economic development of Europe on the one hand, to the retardation of the rest of the world on the other.

The answer is not easy to come by. For one thing, the issue is much

vexed by political commitment and coloured by intellectual bias. Those who are indignant or angry at the wrongs inflicted by the West on the colonial peoples of the world—the nationals of these countries in particular—are inclined to impute the whole Western achievement to exploitation: the Industrial Revolution, say some Indian historians, was accomplished on the backs of the Indian peasant. Marxist historians offer similar judgments, which serve among other things to increase the burden of sin to be laid at the door of capitalism. The effect—and sometimes the aim—is to legitimize such reprisals as the Third World today may be able to wreak on its former masters: in the light of the historical record, vengeance is ostensibly nothing more than retribution. On the other side, those who reject the indictment in whole or in part (and it is not easy on this issue to preserve the nuances), or who give their support to capitalism as against other economic systems, are prone to depreciate the advantages of the colonial relationship to the dominant power and the disadvantages to the dominated. The effort here is to deny or minimize the debt; and since the nature and extent of the obligation of the rich nations to the poor is one of the most sensitive and potentially explosive issues of international relations, the verdict of history is in this case of more than academic interest.

Under the circumstances, it seems clear that we have here the kind of problem on which consensus is impossible. History is not an exact science (many would say that it is not a science at all), and even if we had all the data desirable, there would be disagreement on their interpretation. But we do not have all the data, so that all that one can do in a rapid analysis of this kind is review what seem to be the relevant considerations and see where they lead.

To begin with, one must distinguish between two kinds of return to colonial domination. (Our context here is the so-called Old Imperialism of the 16th to 18th centuries.) The first is the quick, spectacular reward of conquest: the seizure as booty of the accumulated wealth of the conquered society. This was of little moment in most colonial areas, for these were generally poor by European standards. The only significant exceptions—and these, momentous—were the American Indian empires of Mexico and Peru and the Mogul Empire of India. The former yielded at the outset enormous treasures of gold and silver bullion; and then for a century and more supplied a large flow of precious metal from mines; so that much of the subsequent exploration of the New World was motivated by the vain hope of finding other El Dorados. The Indian tribute was smaller; but the adoption into English of such words as *nabob* and *Golconda* is testimony to the riches that the more enterprising and less scrupulous Europeans found there.

The significance of this booty for European economic development

has long been a subject of controversy. Precious metals and jewels are not productive capital; neither are they edible. But in the right hands, they can be used to command and combine the factors of production for useful purposes. In the right hands... The silver of America did little for Spain, which re-exported most of it to pay for military operations in other parts of Europe and for imports of food and manufactures from 'less fortunate' countries. Indeed one might reasonably argue that the colonial windfall did Spain serious harm by encouraging her to rely on tribute rather than work. In similar fashion, the wealth of the nabob returning home from India to England was more likely to go into land and office than into trade, for experience in colonial exaction is poor training for risk-taking ventures in a competitive market.

On the other hand, the Spanish re-export of bullion and the land purchases of nabobs were transfer payments: the wealth did find its way into other hands and constituted a net addition to Europe's and England's money supplies. This in turn presumably eased credit, increased demand, and stimulated industry—in those places that were in a position to respond to this opportunity. Admittedly this was a one-time stimulus that lost force when the inflow of precious metals diminished; plunder, silver mining, and quick monopoly profits are not a solid basis for development at home or abroad. Yet while the inflationary expansion lasted, it promoted abiding changes in the structure of the European economy: new scope for commercial enterprise, greater specialization in agriculture and manufacture, larger concentrations of capital, an increased scale of production in certain branches.

More durable and more stimulating to European economic development was the systematic exploitation of colonial territories through settlement. Practice varied considerably. In some areas (notably Spanish America), the native was impressed into service; in others (the West Indies and the southern colonies of British North America), he proved unwilling or unable to do the work required, and the colonists killed him or drove him off and brought in black slaves from Africa to take his place. Farther north, the settlers did their own work, establishing in the New World societies that were in many respects replicas of what they had known at home. In some places the Europeans constituted a thin surface layer over a far larger mass of Indians and Negroes; in others they were the whole or a substantial part of the population. Whatever the social structure, however, the significance of these colonies for European economic development is that they produced an ever-larger volume of goods for export, primarily food and raw materials, and took in return a growing stream of European manu-

factures. This was not a once-for-all gain. It constituted an enduring increment to the pressure of demand on European industry and thus contributed, as we shall see, to the Industrial Revolution.

To say that colonial possessions contributed to the enrichment and development of certain European countries, however, is one thing; to say that they were a necessary or a sufficient condition of this development, is quite another. The necessity argument implies that if there had been no overseas expansion, there would have been no Industrial Revolution. It is hard to prove or disprove this kind of contrafactual hypothesis. But it is worth observing that a similar argument about the indispensability of imperialism to the sustenance of the European economies in a more advanced stage of development has been put to the test and been found wanting—even in the cases of those countries, Belgium and Holland, most dependent on colonial profits.

The sufficiency thesis is more complicated, yet may be somewhat easier to deal with. It asserts that once Europe achieved superior power, it could despoil and exploit the outside world at will, and the rest—enrichment and industrial development—followed as a matter of course. By implication, the argument imputes enormous rewards to dominion, and assumes that the possession of superior power necessarily entails the rational and effective use of that power for personal or national advantage. Yet the historian must not take anything for granted in this regard—not even the fact of empire, for the overseas expansion of Europe was itself made possible by previous political and technological advances and was not a windfall. Similarly, the shift from plunder to exploitation was not implicit in European dominion. The world, after all, had known (and still knew and would know) other conquering peoples, some of whom had held sway over richer lands than the forests of North America or the semitropical isles of the Caribbean. Yet aside from cases of outright annexation *cum* assimilation, none of these had succeeded in converting their conquests into an enduring source of wealth; rather they had always chosen to seize the quick returns—to loot, take slaves, exact tribute. The decision of certain European powers, therefore, to establish 'plantations', that is to treat their colonies as continuous enterprises was, whatever one may think of its morality, a momentous innovation.[1]

Given the innovation, however, the question then arises of the returns to what Hobsbawm calls the 'new colonialism'. What, after all, constitutes a 'sufficiency' of gain for purposes of industrial revolution?

[1] On the differences between the colonialisms of plunder and of exploitation and the significance of the shift from the one to the other, see especially the stimulating article of Eric Hobsbawm, 'The Crisis of the 17th Century', *Past and Present*, no. 5 (May, 1954), pp. 33–53; no. 6 (November, 1954), pp. 44–65.

We shall have occasion to examine this problem in detail later on, when we compare the contributions of home market and export market to the demand for British manufactures. Suffice it here to say that while the large and growing home market might conceivably have been enough to elicit and sustain a revolution in the mode of production, the export trade (of which the colonial trade formed only a part) could not by itself have done so.

There remains one last point: the effect of European expansion on the colonial areas. Here the record of the early modern period is one of almost unrelieved oppression and brutalization of the indigenous populations. The enormity of the crime is a matter of historical research and debate: Did the Indian population of central Mexico fall from 11 million to 2 million in the first century of Spanish rule?[1] Was the number of slaves shipped from Africa in the sixteenth and seventeenth centuries (to say nothing of later years) 2 million, 3 million, or 5 million?[2] How many died in African wars or captivity before they could be put in the holds of a slave ship? We shall never have precise data on these points. But the effect of European dominion is indisputable: the destruction, eviction, or emasculation of the indigenous civilization.

To say this, however, is not to say that these societies would have effected a significant technological transformation of their own economies had it not been for European colonialism. In spite of current efforts to enhance the achievements of the African and American peoples before the coming of the European, it is clear that none of them was ever in the running for world economic leadership. The only serious contenders, going back to the Middle Ages, were China, India, and the Islamic world. The first was not significantly affected by European imperialism before the late eighteenth century, and by that time, the contest was over. The Muslim world suffered earlier wounds: the Spanish *reconquista*, the Crusades, the endemic piracy of the Mediterranean (which cut both ways). But the sources of the economic backwardness of the Muslim world must be sought, as we have seen, in the cultural and political history of the Islamic heartland—Egypt, Syria, Iraq, Persia; and here the effect of European expansion was not the decisive consideration. The same was true of India. Whatever nefarious deeds one may acribe to imperialism, one can hardly argue

[1] See Sherburne F. Cook and Woodrow Borah, *The Indian Population of Central Mexico 1531–1610* [Ibero-Americana, no. 44] (Berkeley and Los Angeles, 1960).

[2] Daniel P. Mannix and Malcolm Cowley, *Black Cargoes: A History of the Atlantic Slave Trade 1518–1865* (New York, 1962), p. 32, gives the following estimates of slaves shipped from 'all parts of Guinea' to the New World: 900,000 in the sixteenth century; 2,750,000, in the seventeenth.

that the states of the subcontinent were on their way to an industrial revolution before the Europeans interrupted.

In all instances, indeed, the failure of the colonial society to stand up to European aggression was in itself testimony to severe internal weakness. Karl Marx saw it very well in the case of India:[1]

> A country not only divided between Mohammedan and Hindoo, but between tribe and tribe, between caste and caste; a society whose framework was based on a sort of equilibrium, resulting from a general repulsion and constitutional exclusiveness between all its members. Such a country and such a society, were they not the predestined prey of conquest? If we knew nothing of the past history of Hindostan, would there not be the one great and incontestable fact, that even at this moment India is held in English thraldom by an Indian army maintained at the cost of India? India, then, could not escape the fate of being conquered, and the whole of her past history, if it be anything, is the history of the successive conquests she has undergone.

From the side of the victim, therefore, as well as from the side of the conqueror, one cannot take the fact of domination *cum* exploitation for granted. The case of Japan is there to show that an alert and self-disciplined society, though backward in technology and armament, could stand up to European pressure—first by self-imposed isolation and then, when that became impossible, by meeting and matching the Westerner on his own ground of industrialization.

* * * * *

So much for the priority of Europe's industrial revolution. We may now turn to our central concern: why some countries in Europe accomplished this transformation earlier than others; also how the pattern of development differed from one nation to another and why. These are important matters, for they throw light on the general problem of growth and, by implication, *mutatis mutandis*, on the character and difficulties of contemporary industrialization. For this purpose, indeed, western Europe offers an ideal subject of analysis. It offers the possibility of comparing a good many of what would seem to be the relevant variables: we have in Europe large countries and small, rich countries and poor, all forms of government, a rich mosaic of social traditions and organization, a great variety of political experience. Europe also presents for analysis the fundamental contrast between self-generated change—Britain—and emulative response. In sum, if history is the laboratory of the social sciences, the economic evolution of Europe should provide the data for some rewarding experiments.

[1] In an article in the New York *Daily Tribune* of 8 August 1853; reprinted in Karl Marx and Frederick Engels, *Selected Works in Two Volumes* (Moscow, 1958), I, 352.

On the other hand, the very wealth of the material imposes handicaps on the author of a short synthesis. Clearly it is impossible to treat so complex a phenomenon in detail within the compass of a single book. We shall therefore be obliged to concentrate our attention on what seem to be the main threads of the story. In particular, we shall focus to begin with on those industries that have played the decisive role in the general transition: the textile manufacture because it was the first to convert to modern techniques of production and long was far and away the most important in terms of capital invested, labour force, value of product, and the other traditional criteria; metallurgy and chemicals, because of their direct link to all other industries; machine-building, because the machine is the heart of the new economic civilization. Coal mining will be considered not so much for itself (it was not changed so much as the others by the new technique), but as a part of the general problem of energy. And all of these will be situated in the context of industrial organization, a comprehensive rubric that includes not only all aspects of co-ordination of the factors of production, but also the handling and movement of the objects of manufacture in the course of their transformation.

CHAPTER 2

The Industrial Revolution in Britain

In the eighteenth century, a series of inventions transformed the manufacture of cotton in England and gave rise to a new mode of production —the factory system. During these years, other branches of industry effected comparable advances, and all these together, mutually reinforcing one another, made possible further gains on an ever-widening front. The abundance and variety of these innovations almost defy compilation, but they may be subsumed under three principles: the substitution of machines—rapid, regular, precise, tireless—for human skill and effort; the substitution of inanimate for animate sources of power, in particular, the introduction of engines for converting heat into work, thereby opening to man a new and almost unlimited supply of energy; the use of new and far more abundant raw materials, in particular, the substitution of mineral for vegetable or animal substances.

These improvements constitute the Industrial Revolution. They yielded an unprecedented increase in man's productivity and, with it, a substantial rise in income per head. Moreover, this rapid growth was self-sustaining. Where previously, an amelioration of the conditions of existence, hence of survival, and an increase in economic opportunity had always been followed by a rise in population that eventually consumed the gains achieved, now for the first time in history, both the economy and knowledge were growing fast enough to generate a continuing flow of investment and technological innovation, a flow that lifted beyond visible limits the ceiling of Malthus's positive checks. The Industrial Revolution thereby opened a new age of promise. It also transformed the balance of political power, within nations, between nations, and between civilizations; revolutionized the social order; and as much changed man's way of thinking as his way of doing.

In 1760 Britain imported some 2½ million pounds of raw cotton to feed an industry dispersed for the most part through the countryside of Lancashire and existing in conjunction with the linen manufacture, which supplied it with the tough warp yarn it had not yet learned to produce. All of its work was done by hand, usually (excluding dyeing and finishing) in the homes of the workers, occasionally in the small shops of the master weavers. A generation later, in 1787, the consump-

tion of raw cotton was up to 22 million pounds; the cotton manufacture was second only to wool in numbers employed and value of product; most of the fibre consumed was being cleaned, carded, and spun on machines, some driven by water in large mills, some by hand in smaller shops or even in cottages. A half-century later, consumption had increased to 366 million pounds; the cotton manufacture was the most important in the kingdom in value of product, capital invested, and numbers employed; almost all of its employees, except for the still large number of hand-loom weavers, worked in mills under factory discipline. The price of yarn had fallen to perhaps one twentieth of what it had been, and the cheapest Hindu labour could not compete in either quality or quantity with Lancashire's mules and throstles. British cotton goods sold everywhere in the world: exports, a third larger than home consumption, were worth four times those of woollens and worsteds. The cotton mill was the symbol of Britain's industrial greatness; the cotton hand, of her greatest social problem—the rise of an industrial proletariat.

Why did this revolution in the techniques and organization of manufacture occur first in Britain? A few theoretical considerations may help us to organize the argument. Technological change is never automatic. It means the displacement of established methods, damage to vested interests, often serious human dislocations. Under the circumstances, there usually must be a combination of considerations to call forth such a departure and make it possible: (1) an opportunity for improvement due to inadequacy of prevailing techniques,[1] or a need for improvement created by autonomous increases in factor costs; and (2) a degree of superiority such that the new methods pay sufficiently to cover the costs of the change. Implicit in the latter is the assumption that, however much the users of older, less efficient methods may attempt to survive by compressing the costs of the human factors of production, entrepreneurial or labour, the new techniques are enough of an improvement to enable progressive producers to outprice them and displace them.

The technological changes that we denote as the 'Industrial Revolution' implied a far more drastic break with the past than anything since the invention of the wheel. On the entrepreneurial side, they necessitated a sharp redistribution of investment and a concomitant revision of the concept of risk. Where before, almost all the costs of manufacture had been variable—raw materials and labour primarily—more and more would now have to be sunk in fixed plant. The flexibility of the older system had been very advantageous to the entrepreneur: in

[1] The criterion of adequacy would, for my purposes, be marginal costs. Steeply rising costs per unit of one or more factors of production under conditions of growing demand would imply an opportunity for and incentive to technological improvement.

time of depression, he was able to halt production at little cost, resuming work only when and in so far as conditions made advisable. Now he was to be a prisoner of his investment, a situation that many of the traditional merchant-manufacturers found very hard, even impossible, to accept.

For the worker, the transformation was even more fundamental, for not only his occupational role, but his very way of life was at stake. For many—though by no means for all—the introduction of machinery implied for the first time a complete separation from the means of production; the worker became a 'hand'. On almost all, however, the machine imposed a new discipline. No longer could the spinner turn her wheel and the weaver throw his shuttle at home, free of supervision, both in their own good time. Now the work had to be done in a factory, at a pace set by tireless, inanimate equipment, as part of a large team that had to begin, pause, and stop in unison—all under the close eye of overseers, enforcing assiduity by moral, pecuniary, occasionally even physical means of compulsion. The factory was a new kind of prison; the clock a new kind of jailer.

In short, only the strongest incentives could have persuaded entrepreneurs to undertake and accept these changes; and only major advances could have overcome the dogged resistance of labour to the very principle of mechanization.

The origins of the entrepreneurial interest in machines and factory production must be sought in the growing inadequacy of the older modes of production, an inadequacy rooted in internal contradictions, themselves aggravated by external forces.

Of these pre-factory forms of organization, the oldest was the independent craft shop, with master often assisted by one or more journeymen or apprentices. Fairly early, however—as far back as the thirteenth century—this independence broke down in many areas, and the artisan found himself bound to the merchant who supplied his raw materials and sold his finished work. This subordination of the producer to the intermediary (or, less often, of weak producers to strong ones) was a consequence of the growth of the market. Where once the artisan worked for a local clientele, a small but fairly stable group that was bound to him personally as well as by pecuniary interest, he now came to depend on sales through a middleman in distant, competitive markets. He was ill-equipped to cope with the fluctuations inherent in this arrangement. In bad times he might be completely idle, with no one to sell to; and when business improved, he usually had to borrow from his merchant the materials needed to get started again. Once caught on a treadmill of debt—his finished work mortgaged in advance to his creditor—the craftsman rarely regained his independence; his

work sufficed to support him—no more—and he was in fact if not in principle a proletarian, selling not a commodity, but labour.

Aside from his pecuniary difficulties, the local artisan was in no position to know and exploit the needs of distant consumers. Only the merchant could respond to the ebb and flow of demand, calling for changes in the nature of the final product to meet consumer tastes, recruiting additional labour when necessary, supplying tools as well as materials to potential artisans. It was largely in this way that the rural population was drawn into the productive circuit. Very early, urban merchants came to realize that the countryside was a reservoir of cheap labour: peasants eager to eke out the meagre income of the land by working in the off-season, wives and children with free time to prepare the man's work and assist him in his task. And though the country weaver, nail-maker, or cutler was less skilled than the guildsman or journeyman of the town, he was less expensive, for the marginal utility of his free time was, initially at least, low, and his agricultural resources, however modest, enabled him to get by on that much less additional income. Furthermore, rural putting-out was free of guild restrictions on the nature of the product, the techniques of manufacture, and the size of enterprise.

The above description of a long and complex historical process inevitably oversimplifies. If it seems reasonable to assert that, taking Europe as a whole, most putters-out came from the mercantile side, it is important to note the many exceptions: the weavers who became clothiers by hiring their less enterprising neighbours; the fullers and dyers who had accumulated capital in the finishing processes and integrated backwards by contracting directly for yarn and cloth. In some areas, most notably the region around Leeds in the West Riding of Yorkshire, rural artisans organized their own small weaving sheds, joined when necessary to create common facilities, and sold their pieces as independent clothiers in the weekly cloth halls. But even in Yorkshire, this fragmentation of enterprise was characteristic primarily of the woollen trade; in the worsted manufacture, where capital requirements were greater, the productive unit was larger and the merchant putter-out more important.[1]

The English textile industry built its fortune in the late medieval and

[1] In his discussion of the shift from urban to rural industry, P. Mantoux, *The Industrial Revolution in the Eighteenth Century* (London, 1928), pp. 64–6, conveys the impression that the putting-out system was the result of the decay of what he describes as 'domestic manufacture', that is, dispersed independent cottage industry of the kind found in Yorkshire. Often, as we noted, this was true, but even more often, probably, putting out was the product of mercantile initiative seeking new sources of labour and drawing the rural population into the commercial circuit.

early modern periods on rural manufacture. No centre of production, except perhaps Flanders, was so quick to turn from the towns to the countryside; it is estimated that as early as 1400 over half the output of wool cloth was accounted for in this manner.[1] The trend continued: by the mid-eighteenth century, the great preponderance of the British wool manufacture was cottage industry; of all the towns immemorially associated with the wool trade, only Norwich remained as an important urban centre, and it was rapidly declining in relative importance. Allowing for such regional variations, moreover, and for occasional pauses, the industry as a whole had prospered impressively. In the late seventeenth and early eighteenth centuries, at a time when the Italian manufacture was a shadow of its former self, when Dutch cloth output was shrinking steadily, and when France was in the throes of a prolonged depression, British consumption of raw wool was growing at the rate of about 8 per cent a decade; and from about 1740 to 1770, the decennial increase was 13 or 14 per cent.[2]

This growth merits detailed attention, for it was the principal precipitant of the changes we denote by the Industrial Revolution, and understanding it may help us understand the reasons for British precedence in technological and economic development. In part the wool industry grew because of favourable conditions of production. Thus no country had so abundant a supply of raw wool, particularly the long wool required for the lighter, harder, worsted fabrics. And rural manufacture, largely unhampered by guild restrictions or government regulation, was in a position to make the most of this resource advantage by suiting its product to demand and changes in demand. In particular, it was free to develop cheaper fabrics, perhaps less sturdy than the traditional broadcloths and stuffs, but usable and often more comfortable. This freedom to adjust and innovate is particularly important in light industry, where resources and similar material considerations often are less important as locational factors than entrepreneurship. A good example from within the British wool industry is the rapid growth of the Yorkshire worsted trade, to the point where it passed the

[1] H. L. Gray, 'The Production and Exportation of English Woollens in the Fourteenth Century', *English Historical Review*, XXXIX (1924), 32.

[2] P. Deane, 'The Output of the British Woollen Industry in the Eighteenth Century', *J. Econ. Hist.* XVII (1957), 220. These figures are derived from informed contemporary guesses and are therefore gross approximations. But it is the trend that interests us here. On this, compare the much slower growth of the Verviers-Hodimont area near Liège, one of the most enterprising centres of wool manufacture on the Continent. P. Lebrun, *L'industrie de la laine à Verviers pendant le XVIIIe et le début du XIXe siècle* (Liège, 1948), pp. 518–19. Note also the difference in size of output between Yorkshire alone (aulnage returns in T. S. Ashton, *An Economic History of England: the Eighteenth Century* (London, 1955), pp. 249–50) and the Verviers area.

older centre of East Anglia in the course of the eighteenth century; compare Clapham's explanation: 'the ordinary case of a pushing, hard-working locality with certain slight advantages, attacking the lower grades of an expanding industry'.[1] We shall have occasion to remark comparable examples of the advantages of entrepreneurial freedom when we turn to the continental countries. In the meantime, we may note that the British wool manufacture profited the more from its liberty because some of its most dangerous competitors across the Channel were being subjected in the seventeenth and early eighteenth centuries to increasing regulation and control.

Finally, one should cite the relative freedom of British industry from the disturbance and destruction of war, the uneven but long and often rich inflow of skilled foreign artisans, and the access of the producing centres to water transport, hence distant markets—all factors conducive to lower costs of manufacture and distribution.

On the demand side, the British wool manufacture was comparably favoured. The population of the kingdom was not large, but it was growing, faster probably by the middle of the eighteenth century than that of any of the countries across the Channel. From not quite 6 millions around 1700, it rose to almost 9 millions in 1800; 70–90 per cent of the gain came in the second half of the period.[2] What is more, the absence of internal customs barriers or feudal tolls created in Britain the largest coherent market in Europe. This political unity was confirmed by the geography of the island: the land mass was small; the topography, easy; the coastline, deeply indented. By contrast, a country like France, with more than three times as many people, was cut up by internal customs barriers into three major trade areas, and by informal custom, obsolete tolls and charges, and, above all, poor communications into a mosaic of semi-autarkic cells.

Moreover, what nature bestowed, man improved. From the mid-seventeenth century on, there was a continuous and growing investment of both public and private resources in the extension of the river system and the construction of new roads and bridges. By 1750 there were over a thousand miles of navigable streams in Britain; and Parliament

[1] J. H. Clapham, 'The Transference of the Worsted Industry from Norfolk to the West Riding', *Econ. J.* xx (1910), 203. Eric M. Sigsworth, *Black Dyke Mills: a History: with Introductory Chapters on the Development of the Worsted Industry in the Nineteenth Century* (Liverpool: University Press, 1958), p. 17, subscribes to this point of view.

[2] For different but roughly concordant estimates of this increase, see Phyllis Deane and W. A. Cole, *British Economic Growth 1688–1959: Trends and Structure* (Cambridge, 1962), p. 5, n. 3. In the same period, the population of France went from about 20 to 27½ millions. E. Levasseur, *La population française* (3 vols.; Paris, 1889), I, 201–6, 215–18.