

My Kingdom for a Tree: The Ecological Basis of The Industrial Revolution
James L. Starkey

...the global triumph of capitalism is the major theme of history in the decades after 1848. It was the triumph of a society which believed that economic growth rested on competitive private enterprise, on success in buying everything in the cheapest market (including labor) and selling in the dearest - Eric Hobsbawm [1975 p.1]

The great frozen ice-cap of the world's traditional agrarian systems and rural social relations lay above the fertile soil of economic growth. It had at all costs to be melted, so that the soil could be ploughed by the forces of profit-pursuing private enterprise. This implied three kinds of changes. In the first place land had to be turned into a commodity, possessed by private owners...In the second place it had to pass into the ownership of a class of men willing to develop its productive resources for the market and impelled by reason i.e. enlightened self-interest and profit. In the third place the great mass of rural population had in some way to be transformed...into freely mobile wage workers for the growing non-agricultural sector of the economy - Eric Hobsbawm [p. 149].

The modern industrial proletariat was introduced to its role not so much by the attraction of monetary reward but by compulsion force and fear - Sidney Pollard

As for unhealthfulness, it may well be supposed, that although seasoned bodies may and do live near as long in London as is elsewhere, yet newcomers and children do not; for the smokes, stinks and close air are less healthful than that of the country...John Graunt - 1662

English Life on the verge

On the eve of the Industrial Revolution the human prospect in England was bleak. Just as it had before the culling of the great plague, the English population had grown robustly and once again England encountered the grim regime of the law of diminishing returns. Indeed, “if a time machine had transported a fourteenth century peasant to his village in the late seventeenth century he would have scarcely noted the difference.” [Rothschild p. 20]. 90% of the population still lived in rural areas. Those not belonging to the social elite could hope for, at the very best, a windowless hovel with a dirt floor. Water was drawn from wells or a nearby stream. The basic food was barley bread. Overall life expectancy was thirty-two years and nearly one-third of children died before the age of fifteen. A worker could expect to live to the age of 22. Because life was so short, especially among the poor, about one-third of children were orphans. Divorce was unheard of as spouses more likely died from disease or, in the case of women, in childbirth. One would have searched the world in vain for a “savage” who would have been willing to trade places with a “civilized” Englishman. Over the next 150 years the condition of the English “working class” only would get worse. But, some time on or about

1840-50 the condition of the working class would begin to improve. Of course, no one could see it coming. In 1844, Engels painted a horrific portrait of misery and exploitation in *The Condition of the Working Class in England*:

I think the people will not endure more than another crisis. The next one in 1846 or 1847 will probably bring with it the repeal of the Corn Laws and the enactment of the Charter. What revolutionary movements the Charter may give rise to remains to be seen. But by the time of the next crisis which, according to the analogy of its predecessors, must break out in 1852 or 1853, the English people will have had enough of being plundered by the capitalists and left to starve when the capitalists no longer require their services. If the English bourgeoisie does not pause to reflect - and to all appearances it will certainly not do so - a revolution will follow with which none hitherto can be compared [Engels, 1892 p. 296, quoted in Laidler p. 174]

Engels was partly correct, the Corn Laws were repealed in 1846, but the Chartist Movement failed, the franchise was not extended to all *males* until 1884. In 1848, revolution broke out all over Europe. In 1848, Metternich, the Austrian statesman, was certain that Europe was about to experience "another 1793." In Paris, the workers threatened the National Assembly with the battle cry "bread or lead"[Laidler p.143]. War broke out on the streets of Paris, but the "half-starved and poorly equipped" workers proved no match for French Troops. In a panic about the threat of the "gray ghost of the proletariat" the bourgeois General Assembly elected Louis Napoleon Bonaparte (Napoleon III), Nephew to Napoleon Bonaparte, president beginning what would be called the "Second Empire." But, there was no revolution in England. Rather, after the crisis of 1847, England was growing by "leaps and bounds" [Laidler p. 174]. The revolution did not occur because the material condition of the working class began to improve as the English economy exploded. Writing in the 1892 edition of *The Condition of the Working Class in England* in 1844, Engels recognized the period after 1847 as "the dawn of the industrial era."

The repeal of the Corn Laws and the financial reforms subsequent thereto gave to English industry all the elbow room they had asked for. The discovery of the California and Australian Gold fields followed in rapid succession. The colonial market developed at an increasing rate their capacity for absorbing English goods. In India millions of hand weavers were finally crushed out by the Lancashire power-loom. China was more and more being opened up. Above all the United States - then commercially speaking, a mere colonial market, but by far the biggest of them all - underwent an economic development astounding even for that rapidly progressive country. And, finally, the new means of communication introduced at the close of the preceding period - railways, and ocean steamers - were now worked out on an international scale; they realized actually what had hitherto existed only potentially, a world market. This world market, at first, was composed of a number of chiefly agricultural countries grouped around one manufacturing center - England - which consumed the greater part of their raw produce and supplied them in return with a greater part of their requirements in manufactured articles. No wonder England's

industrial progress was colossal and unparalleled and such that the status of 1844 now appears to us as comparatively primitive and insignificant [quoted in Laidler p. 174].

Engels, quite prophetically, and following Malthus, wondered how long England's prosperity would last. "How will it be," he pondered, "when continental, and especially American, goods flow in ever increasing quantities - when the predominating share, still held by British manufacturers, will become reduced from year to year?" [quoted in Laidler p. 175]

The classical economists writing during the first part of industrial revolution did not see it happening, because, while all the pieces were in place by 1830, it had not *actually* happened. Adam Smith expected the national product to rise at a moderate pace following the expansion of trade and specialization. David Ricardo worried that the absorption by land rents of productivity growth would produce stagnation. Malthus expected living standards to remain at the subsistence level due to the pressures of population. Marx saw nothing short of a revolution would stop the "immiseration" of the working classes. The term "industrial revolution" was not used until Historian Arnold Toynbee used it in a lecture in 1881¹, some fifty years after it ended. But, eventually real wages did rise significantly, the share of national income going to rent fell by 50% and the share of national income going to wages rose [North p.160-162]. Economic historian and Nobel Laureate Douglas North contends the economists missed the "revolution" because there was little remarkable about it *at the time* :

Population..was growing prior to the century of the industrial revolution; large cities existed before the industrial towns grew up; and the income of Englishmen increased prior to the birth of Adam Smith as well as during his life and the lives of the other classical economists. During this period there were more and more agricultural workers in total; agriculture would not have appeared to be a declining industry to a contemporary observer. Large factories had existed prior to the Industrial Revolution, and steam engines had been employed for decades before James Watt's steam engine. The fabled Watt engine was simply an improvement of the previously existing Newcomen engines. So perhaps it is not surprising that the classical economists missed the Industrial Revolution ; for what was new was the magnitude of the changes not their revolutionary character [North p. 161].

North, following Engels insists that the truly revolutionary changes occurred, since 1850; in the 125 after the Industrial Revolution [North p. 161]. But, in 1885, Engels was wary the gains to the English working class were only temporary. The workers standard of living was threatened by "the great body of the unemployed reserve, by the constant superceding of hands by new machinery, [and] by the immigration of the agricultural population, now too, more and more superceded by machinery" [quoted in Laidler p. 175]. Engels did see a permanent improvement in the lives of factory workers protected by the ten-hour day and for those in

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There is some controversy as to when this terms was first used. See text below.

labor unions where “grown men” are protected from the competition of women and children and machines [Laidler p. 175]. Engels attributes the failure of England to produce a socialist movement to the gains the workers derived from their share, however meager, of the benefits of the English industrial monopoly [Laidler p. 176].

Excepting only the invention of agriculture, the Industrial Revolution may be the most important "event" in human history [Hobsbawm 1969 p. 29]. The term "Industrial Revolution" was used in the 1820s when French and English socialists, engaged in intense criticism of the new society it created, so named it. But exactly what is meant by this phrase? The socialists saw this phenomenon to be as "sudden, abrupt, qualitative and fundamental" and as significant as the French Revolution, thus the peculiar term [Hobsbawm 1969 p. 29]. Concisely defined by historian Eric Hobsbawm, the Industrial Revolution:

means that some time in the 1780s, and for the first time in human history, the shackles were taken off the productive power of human societies, which henceforth became capable of the constant, rapid and up to the present limitless multiplication of men, goods and services. This is now known to economists as the "take-off into self-sustained growth." No previous society had been able to break through the ceiling which a pre-industrial social structure, defective science and technology, and consequently periodic breakdown, famine and death, imposed on production [1969 p. 28].

Toynbee imagined the shackles to be the Mercantilist restrictions that contained free competition i.e. the poor laws, usury laws, the navigation acts and the Statue of Artificers, in short laissez-faire [North p. 166-167]. Douglas North adds that new forms of property rights that protected the profit of innovators, e.g. patents² and improved forms of contract law were as important. Indeed, North contends that these legal innovations, produced by the bourgeois parliament, were crucial. North attributes the slow rate of innovation before this period to the inability of an innovator to capture the profit from their inventions³, leaving little incentive to be creative [North p. 167]. Note that the revolution is defined in terms of institutional change rather than technological change.

Thinking of the Industrial Revolution brings to mind, for most, images of factories filled with steam powered textile machinery. The sense is of a technological revolution that followed from the spontaneous development of new inventions as science and engineering developed the knowledge base. Historian Will Durant characterized the Middle Ages as the period that "conquered the wilderness, won the great war against the forest, jungle, marsh and sea and

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The Statue of Monopolies was passed in 1624. Innovation seems to operate with a substantial lag.

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Innovations could be copied at no cost by others [North p. 164].

yoked the soil to the will of man [Durant 1950 p.1083]. The Industrial Revolution, then was another "great leap forward" where man used science and ingenuity to tame nature and laid an ever stronger foundation to the enlightenment, humanist belief in progress and perfectibility. But, the Industrial Revolution was not one of science:

Fortunately, few intellectual refinements were necessary to make the Industrial Revolution. Its technical inventions were exceedingly modest, and in no way beyond the scope of intelligent artisans experimenting in their workshops, or of the constructive capacities of carpenters, millwrights and locksmiths: the flying shuttle, the spinning jenny, the mule. Even its scientifically most sophisticated machine, James Watt's rotary steam-engine (1784), required no more physics than had been available for the best part of a century [Hobsbawm 1969 p. 30].

Douglas North calls the improvements of technique during the industrial revolution "learning by doing" as opposed to innovations coming out of developments in basic science [North p. 162]. It was "fortunate" that a well-educated scientists and workers was not a prerequisite for the Revolution as England was woefully deficient in both. While both the French and the Germans had well developed systems of technical-vocational education in the *Ecole Polytechnique and Bergakademie* respectively, the English had none. "English education was a joke in poor taste" writes Eric Hobsbawm. Just as the Roman Church forbade the reading of the bible, the English would not educate the poor out of fear of creating a revolutionary class. The leading English Universities, Oxford and Cambridge, as Smith and Bentham had observed, were intellectually dull, as were the "somnolent" preparatory public schools. The English elites who wanted a real education for their children sent them to Scottish Universities [Hobsbawm 1969 p. 30].

But, to understand the Industrial Revolution in only technological terms is to understate its truly revolutionary nature. The industrial revolution was the product of an economic, social and political revolution and in turn produced a social and political revolution in its wake. It took a political revolution to melt the "great frozen ice-cap" of traditional society. The economic revolution made the political revolution possible and the political revolution produced the social revolution. A series of fundamental infrastructural changes produced the Glorious Revolution of 1688. The product of the Glorious Revolution was a change in Structure and Superstructure that enabled the transformation of agriculture, establishment of a commercial social and political ideology, a vesting of political power in the hands of the profit-minded:

a century had passed since the first King had been formally tried and executed by his people, and since private profit and economic development had become accepted as the supreme objects of government policy...A relative handful of commercially-minded landlords almost monopolized the land...manufacture had long been diffused throughout and unfeudal countryside...and a considerable amount of social overhead capital was already being created, notably in shipping, port facilities, and the improvement of roads and waterways. Politics were already geared to profit... It was accepted that money not

only talked but governed. All the industrialists had to get to be accepted among the governors of society was enough money [Hobsbawm 1969 p. 31].

The fundamental transformation of agriculture was "social" as opposed to technical. The social revolution liquidated the medieval communal system of agriculture with its open fields and common land which emphasized a non-commercial attitude toward farming [Hobsbawm 1969 p. 48]. The Speenhamland System and the Corn Laws were "rearguard actions" in this social transformation from an agrarian to an industrial society. This "uniquely radical" transformation of agriculture, by facilitating the feeding, and indeed the improved nutrition, of the urban proletariat, enabled the Industrial Revolution [Hobsbawm 1969 p. 48]. The economic gains of the "great transformation" were spectacular, but the social costs were high as tens of thousands of the rural poor were reduced to "demoralized destitution" [Hobsbawm 1969 p. 49].

All of these events, it should be emphasized, took place in the context of extreme reproductive pressure, that is, England had its back against an ecological wall as manifest in severe malnutrition, regular famines and, consequent of the timber famine, a real shortage of fuel energy. These were the problems that impelled England on its radical course; England had to change or starve.

The Factory and the Putting-Out System

Capitalists who wished to engage in the production of goods had to contend with the Guilds which monopolized the cities. With production under the control of guilds, that is the artisans themselves, there was little role for the capitalist in the production process and therefore no opportunity for profit. The guilds controlled product and the work process. The guild workman sold a product not his labor. To be sure, control over production in the guilds was hierarchical: masters controlled journeymen who, in turn, controlled apprentices. But each was a producer and journeymen and apprentices could rise in the hierarchy. The guild worker was not permanently subordinated to a position where he had no control over production and where he had no product to sell [Marglin p. 289]. Consequently, if they wanted to earn profits from production, early "capitalist" manufacturing was forced to use the so-called putting out system.

In this system, rural craftsmen and their wives would work on material supplied by the capitalist in their cottages during the periods of slack time, winter and other slow periods. This system dominated manufacturing for about 300 years and helped bridge the gap between the end of an agrarian system and one based on urban factory industry. The Nottingham hosiery industry consisted not of a large factory, but of 1750 "putters out" operating hosiery frame in their homes [Toynbee p.26]. The improvement of manufacturing technology, that is, increased specialization and the division of labor was retarded by the lack of a large market for manufactured goods

Much industry was still following the medieval mode of home and small shop production, but factories were beginning to appear in the textile and iron industries. In the new textile factories "wool sorters, combers, spinners, weavers, pressers, and dyers work together" but modern textile machinery had not yet appeared. Glasgow had a textile factory that employed some 1,400 people. Long before they were recorded by Adam Smith in 1776, the

division of labor and specialization had made their appearance. Sir William Petty noted in 1683 that watchmaking had been so organized:

if one man shall make the wheels, another the spring, another shall engrave the dial plate, and another shall make the cases, then the watch will be better and cheaper made than if the whole work be done by one man” [quoted in Durant 1963 p. 257]

The emergence of the factory is usually identified with, and indeed, by many, as the industrial revolution. Economic historians traditionally describe the industrial revolution in terms centered on the “technological superiority of large-scale machinery” gathered in factories and powered by “newly harnessed sources of energy - power and steam.” [Marglin p. 293]. But, actually the factory form of production emerged much earlier. In its essence the factory is an organizational form that brings labor under the supervision of the employer for regular hours. Rather than being the “necessary outcome of the use of machinery” the cost reducing role of the factory emanated from its facilitation of the control over labor [Marglin p. 294]. Economic historian, David Landes was quite clear on this point :”The essence of the factory is discipline- the opportunity it affords the direction and coordination of labor” [quoted in Marglin p. 294].

As social scientists we must take a broader perspective than the pecuniary interest of capitalists. Certainly, capitalists using the factory were able to produce at lower cost, but it does not follow that this was a technologically superior form of production, because there are other costs of factory production that are borne by workers. The factory forces workers to work far more hours and at much greater intensity than they would choose. Capitalist costs are reduced, profits rise, but these gains come at the expense of the quality of life of the workers - a classic example of an externality.

18th century observers complained bitterly of the “indiscipline of the laboring classes” as manifest in their unwillingness to work any longer than is necessary for their subsistence, that is, what they need “just to live” [Marglin p. 298]. “Indiscipline, in other words, meant that as wages rose, workers chose to work less. In more neutral language, laziness was simply a preference for leisure! Far from being an ‘unreasonable inversion of the laws of sensible economic behavior’ a backward-bending labor supply curve is a most natural phenomenon as long as the individual worker controls the supply of labor” [Marglin p. 298]. Needless to say the capitalist intent on “accumulation” could not rest content with the workers preference for leisure. Even in the midst of the putting-out era capitalists resorted to law to force domestic workers to complete work within a specific period of time. In 1749 the period was set at 21 days, but by 1777 it had been reduced to eight days. Yet this mechanism proved inadequate. The factory, on the other hand, reduced the workers choice to work long hours or to not work at all [Marglin p. 298]. One keen observer noted that contrary to the conventional view, the genius of Richard Arkwright lay not in his mechanical invention [the Spinning Jenny], but in his managerial abilities. In particular those that were necessary to train “human beings to renounce their desultory habits of work, and to identify themselves with the unvarying regularity of the complex automaton. To devise and administer a successful code of factory discipline, suited to the necessities of factory diligence, was a Herculean enterprise, the noble achievement of Arkwright.” Even at the present day...*it is found nearly impossible to convert*

persons past the age of puberty, whether drawn from rural or from handicraft occupations, into useful factory hands. [Marglin p. 295, emphasis added]. Here is revealed both the reluctance of adults to accept work in the factory and the preference of factories for child labor!

People were generally unwilling to submit to this regimentation and certainly even less willing to endure long regular hours. The factory, thus, could not emerge as long as people had opportunities in farming or handicrafts in their cottages. However, as enclosure proceeded opportunities to work on the land and their cottages disappeared. Enclosure had been going on for centuries, but it accelerated in the 18th century. Between 1710, 334,974 acres of common land were enclosed. Over the next 80 years some 7 million acres were enclosed [Toynbee p. 12] The lack of enclosure in France undoubtedly contributes a great deal to the explanation of why the French lagged behind England in industrialization.

. The market was limited by an infernally poor internal transportation system over which to move goods to market [Toynbee p.24]. A key part of the Industrial Revolution would be the railroad and the broadening of the market it made possible.

The putting-out system economized on capital as the capitalist supplied only the variable capital (the materials) the workers provided the fixed capital (spinning wheels & looms), but it suffered, from the perspective of the capitalists from many defects. First, there was lack of quality control. Second, the capitalist could not control the pace or the hours of work. As more capital became available (through primitive accumulation) and as more dispossessed labor became available, large central workshops were established where the capitalist could control, quality, pace, and hours of work. Having no other alternative the proletarians (the disinherited) submitted to the discipline and long hours of the factory. They used the same machines (looms etc), now owned by the capitalist, but they now worked under a new control system. The Statute of Artificers (1563) specified that hours of work were to be from 5 am to 7 pm during the spring and summer and sunup to sundown during the winter [Dillard 120]. If any independent craftsmen were left they were soon driven out of business by the cheaper products of the capitalists.

The factory system produced a major change in the life of the average workingman that was not considered salutary:

Certainly the domestic system combining industry and farming represented no Utopia. The homes of workers were hovels, diets were inadequate, clothes were often rags, and incomes were miserably low. Yet the domestic system was associated with a relatively carefree way of life in comparison with factory employment which was viewed little better than imprisonment...workers accustomed to the rural way of life found the regimented work schedule of the factory quite intolerable [Dillard p. 249].

The factory was an organizational device to improve the monitoring of workers, but it “had the additional consequence of suggesting to entrepreneurs new productive combinations and specifically machines to replace human hands in the production process” [North p. 169]. The new machines followed the institution of the factory.

Not only workers resented the new factories and machinery. Medieval guilds opposed any new method of production including machines that posed a competitive threat to their monopoly on production. New techniques and machines make existing specialized skills

obsolete thus posing a real threat to the craftsmen's livelihood. (Ask your professors what they think of televised college courses). The City of Dantzic so feared the potential unemployment that they had the inventor of a new form of loom strangled [Dillard p.246]. Arkwright's spinning machine won the opposition of the English spinners. In many cases the landed aristocracy supported the plaintiffs as they feared unemployment would push up the "poor rates" [Dillard p. 246]. The most violent reactions, the so-called "Luddite risings" occurred as early as 1799 and continued in waves until 1815. In 1799 an armed band of eight thousand workers attacked a mill and burned it to the ground, as Robert Heilbroner puts it "in unreasoning defiance of its cold implacable mechanical efficiency" [Heilbroner p. 106]. By 1811 armed bands of Luddite terrorists roved about the countryside "smashing machines and burning factories" [Dillard p. 246]. Although these events were spontaneous and random, driven by worker "hatred of the factories they saw as prisons" it came to be believed that they were all being directed by "General Ludd" [Heilbroner p. 106]. The Luddites had the sympathy of many petit-bourgeoisie (small businessmen) and farmers because they were as threatened by the power of concentrated wealth as the workers. These groups also saw themselves as victims of the "diabolical minority of selfish innovators" whom they believed were the "destroyers of men lives" [Hobsbawm p. 39, 201]

The industrial revolution (1760-1830) was not the result of what Thorstein Veblen would call the "instinct for workmanship," that is, the human penchant to improve things through the application of rational thought and ingenuity. No doubt, human ingenuity made the industrial revolution possible, but other forces, the relentless pressure of growing population, the consequent scarcity of land and other resources, especially timber, made it necessary. As we have seen people generally do not change the way they earn their daily bread unless they are forced to do so. The Kung! San would indeed plant if there were not so many Mongongo nuts in the world, but not until then. We have also seen that the transition from gathering and hunting to horticulture and then to agriculture involved a decline in the standard of living in the dimensions of work (quality and quantity), nutrition, and community. To allow more to live all had to live at a lower standard. We shall see that the industrial revolution also was a response to reproductive pressure and that living standards also declined following it. Only a relatively small part of the world's population has enjoyed the benefits of industrialization, others such as the nations of the developing world, indigenous populations, the working masses, other species and the world ecosystem have suffered degradation in many important ways.

The Revolutions of 1848

In 1848 Karl Marx and Fredrich Engels published the *Communist Manifesto* which predicted the onset of a great revolution. The sense that revolution was imminent was pervasive. Alexis de Tocqueville warned the French Chamber of Deputies that "we are sleeping on a volcano...Do you not see that the earth trembles anew? A wind of revolution blows, the storm is on the horizon" [quoted in Hobsbawm 1976 p. 3]. Some "sixty years of the swiftest industrial progress the world had ever known had created a new working class whose miseries were likely to be explosive" [Robertson p. 4] The fear of the people instilled in aristocrats since 1789 now dwelled among the "middle classes of Europe [who] were frightened of the people." [Hobsbawm 1976 p. 3]. To the middle classes the demand of the people for

“democracy,” the right to vote,⁴ and a redistribution of wealth meant nothing more than the demand for socialism [Hobsbawm 1976 p. 3, Robertson p. 14]. In retrospect, Marx and Engels must have seem truly prophetic. Within hours of the publication of the Manifesto, the French Monarchy was overthrown.⁵ In a period know by historians as the “springtime of peoples” revolutions, driven primarily by the hunger of “laboring poor” and their ferocious “hatred for the rich” broke out all over Europe and resulted in the “virtually simultaneous overthrow of old regimes over the bulk of continental Europe west of Russian and Turkish Empires, from Copenhagen [Denmark] to Palermo [Sicily], from Brasov [Romania] to Barcelona [Spain]” [Hobsbawm 1976 p. 2, 15]. Only England was spared. England had its Chartist Movement which always threatened to devolve into violence. The English workers “stomachs [were] as hungry as German one’s” one German observer noted, yet “they felt better because they were allowed to grumble,” that is, the Government insisted that it would listen to the grievances of the workers [Robertson p. 405]. Actually, the English workers though they endured “awful sufferings as victims of the factory system” were better off than German workers [Robertson p. 407]. “In England a man who had only potatoes to eat called himself starving, while in... Germany a man who had potatoes was well off. Free speech and goodwill and wealth⁶ - these made England safe” [Robertson p. 407].

The English Chartist Movement expired and the continental revolutions failed so that “within eighteen months of its outbreak all but one of the regimes, the French Republic, overthrow had been restored [Hobsbawm 1976 p.10]. The liberal Bourgeoisie saw the starving masses as a greater threat to their property than the conservative royalists and sided with the latter to crush the worker’s “red revolution” [Hobsbawm 1976 p. 19]. As for the “laboring poor” themselves “they lacked the organization, the maturity, the leadership, perhaps most of all the historical conjuncture, to provide a political alternative. Strong enough to make the prospect of social revolution look real and menacing, they were too weak to do more than frighten their enemies” [Hobsbawm 1976 p. 21]. The workers had no political ideology to carry them forward once they had achieved their military victory. The “masses,” as they did frequently in the Greece of Plato soon fell under the sway of demagogues, like Louis Napoleon, who were able to manage the masses with good “public relations” [Hobsbawm 1976 p. 26]. More importantly, the so-called “second industrial revolution” would so improve the conditions of the working classes as to nullify any revolutionary impulses that might remain.

Yet 1848 was “not merely a brief historical episode with out consequence:”

4 In France, for example, only 250,000 males out of nine million could votes as a consequence of property restrictions [Robertson p. 15].

4. Not a single revolutionary leader in 1848 had read the Manifesto and none had any perception that they were involved in a great “class struggle.” All of these leaders still held to the idea that the revolutionary changes they demanded would benefit all classes [Robertson p. 6].

6 Of course the Irish on England’s “second Island” shared none of these benefits. Here the English failed to “live up to their theories” [Robertson p. 407]

It marked the end, at least in Western Europe, of the politics of tradition, of the monarchies which believed that their peoples accepted, even welcomed, the rule of divinely appointed dynasties presiding over hierarchically stratified societies, sanctioned by traditional religion, of the belief in the patriarchal rights and duties of social and economic superiors...Henceforth the forces of conservatism, privilege and wealth would have to defend themselves in new ways [Hobsbawm 1976 p. 25]

The Great Boom

The bourgeoisie, by the rapid improvement of all instruments of production, by the immensely facilitated means of communication, draws all, seven the most barbarian nations into civilization... In one word it creates the world in its own image - K. Marx & F. Engels, 1848

The year 1848 launched the second phase of the industrial revolution. Between 1800 and 1840 world trade had "not quite doubled." [Hobsbawm p. 34]. But, between 1850 and 1870 world trade increased 260% [ibid p. 34]. IN 1850 England produced 2.5 million tons of Iron. By 1870 England's production passed six million tons. The world output of coal and pig-iron multiplied by five in the same two decades. In 1850 the world's total steam power was only four million horsepower compared to 18.5 million horsepower in 1870 [Hobsbawm p. 40-41].

Several factors accounted for this explosion in trade and production. Surely the gold discoveries in California in 1849 increased the supply of specie money. In just a few years the world supply of gold increased by a factor of seven! [Hobsbawm p. 34]. But the key reason was the expansion of railroads and the steamship that unified the world into a global marketplace. In 1848 the circumnavigation of the globe would have taken no less than eleven months, but by 1873 an American travel agent offered an 80 day around the world trip [Hobsbawm p. 52-53].

In order for the Industrial Revolution to succeed a vast world market for exports was needed to produce the low unit costs of production that make for large profits. If vast quantities of goods can be supplied, no profit can be made until they are sold. Douglas North holds that the opening of vast new markets provided the incentives that produced the Industrial Revolution [North p. 167]. England, with a very aggressive state policy (war and imperial rule), secured for its industrialists, a virtual monopoly on world textile markets. The English manufacturers had a monopoly on the market in the New World English Colonies, India, Africa and Asia .

The Industrial Revolution was centered on cotton textiles. As late as 1830 the only "modern" "factories" were confined to the cotton industry. Other textile industries were slower to develop, and as late as the 1840s the development of other industries was negligible. It was cotton that made the Industrial Revolution: between 1816 and 1848 cotton accounted for about half of all British exports [Hobsbawm 1969 p. 38].

The early English textile industry was based on wool. The powerful wool interests had been able to limit the amount of cotton *calicoes* imported from India by the East India Company leaving the door for a native cotton industry to get a foothold, but the cotton garment was not popular in England. The cotton industry needed overseas markets provided by the colonial trade, particularly that involving slaves. Thus, cotton and the nasty business of

slavery would co-evolve.

Cotton manufacture began in the major colonial port areas of Glasgow, Bristol and Liverpool. As the slave trade grew so did the cotton business. The slaves were purchased with Lancashire cotton textiles and sold to the plantations of the West Indies where they would produce the bulk of the cotton used in the British industry. They would also become important consumers of cotton goods. The demand for raw cotton by the Lancashire Mills would expand to the Colonies of the American South. Slavery in America was "extended and maintained by the insatiable and rocketing demands of the Lancashire Mills to which they supplied the bulk of their raw cotton" [Hobsbawm 1969 p. 34]. Between 1750 and 1769, based primarily on the growth of the colonial trade, the exports cotton textiles from England increased by a factor of ten. By 1814 the English exported four yards of cloth for every three used at home.

After the end of the war with France, the European market for cotton was wide open, but it was dwarfed by the market in the "underdeveloped" world. Europe took some 200 million yards of cotton in 1840, but the "underdeveloped world took 529 million. India, a major supplier of cotton to Europe, had been "systematically deindustrialized," a now imported 145 yards of Lancashire cotton [Hobsbawm 1969 p. 35].

The fantastic rates of return earned in cotton allowed the industry to be self-financing. Indeed, the profits produced by the cotton industry and the general prosperity it produced were far too large to be absorbed by available investment opportunities

:

The fundamental fact about Britain in the first two generations of the Industrial Revolution was, the comfortable and rich classes accumulated income so fast and in such vast quantities as to exceeded all available possibilities of spending and investment. No doubt feudal and aristocratic societies would have succeeded in throwing away a great deal of this in riotous living, luxury building and other uneconomic activities... But, the bulk of the middle-classes, who formed the main investment public, were still savers rather than spenders... Virtually untaxed, the middle-classes, therefore continued to accumulate among the hungry populace, whose hunger was the counterpart of their accumulation. As they were not peasants, content to hoard their savings in woolen stockings or golden bangles, they had to find profitable investment for them. But where? Existing industries were [unable] to absorb only part of it. What was needed was a sponge large enough to hold all of it [Hobsbawm 1969 p. 46].

The Second Industrial Revolution.

The surplus capital found an outlet in railroads. The investment in railroads, put the Industrial Revolution in high gear. The railroad not only brought English goods to the far corners of the world, they set off the expansion of entire new industries - the basic capital goods industries such as Iron; each mile of track required 300 tons of iron just for the tracks! [Hobsbawm 1969 p. 45]. Over the first three decades of railroad construction British iron output tripled as did the output of coal.

The English built railroads in England, India, the United States and all over the world.

The railroads were built by British contractors and financed with British capital. In the years 1834 to 1836 some Seventy Million in pound sterling was put into railroads in England. By 1850 England had over 6,621 miles of railroad [Clough & Cole p. 450]:

The iron road, pushing its huge smoke plumed snakes at the speed of wind across countries, and continents, whose embankments and cuttings, bridges and stations, formed a body of public building beside which the pyramids and the Roman aqueducts and even the Great Wall of China paled into provincialism was the very symbol of man's triumph through technology [Hobsbawm 1969 p. 44].

The railroads in the United States reduced the transportation costs of cotton and expanded the market for English goods. More generally, by drastically reducing transport costs, railroads greatly increased the world market for English goods. Railroad construction directly created tens of thousands of jobs, and tens of thousands more in iron, coal, and other industries. Ironically, the investors in British railroads did not all that well. Investment in railroads appears to have been a "irrational passion." [Hobsbawm p. 45]. By 1850 the average return on the 240 million pounds of railroad investments was about 3.7%. While not spectacular the return was far better than that English investors had been getting on foreign investments in South America, Greece and North America which had a high likelihood of turning into "worthless pieces of paper" [Hobsbawm 1969 p. 45].

Fossil Energy

The formidable group of innovations [known as the "Industrial Revolution"] should not be regarded as the fruits of a society's search for progress, but as the outcome of a valiant struggle of a society with its back to the ecological wall [Richard Wilkinson, Progress and Poverty, p 126].

The industrial revolution was the contingent consequence of an ecological crisis that took the form of an energy crisis. Strictly speaking the industrial revolution was based on abundant supplies of cheap coal. The technology that made the industrial revolution possible was the serendipitous result of solving the problem of getting water out of coal mines. England was also fortunate, due to its terrain, to be able to transport coal cheaply. But, England was driven to mining coal in the first place due to massive deforestation. Coal mining solved a major economic problem, but the solution came at a very high cost - extensive air and water pollution and a great deal of misery for the people who had to work in coal mines.

The industrial revolution was the ultimate response to an energy shortage. The technology of the industrial revolution, the steam engine, was known by the third century A.D., but aside from amusing toys, there was no practical use for it. The industrial revolution emerged from an ecological crisis manifest as an energy shortage. The principal sources of energy, water power and timber, were for all intents and purposes exhausted. All of the potential mill sites along rivers had been used up and because of its great scarcity lumber became very expensive. Early in the 13th century England was importing wood from

Scandinavia and Germany [Gimpel 80].

In 1971, the *Times* of London reported that Robin Hood's Sherwood forest had been reduced to a mere 300 trees. While current pollution had been responsible for some of the destruction of the forest, the greatest proportion of the damage was done in the middle ages. In order to encourage the growth of the English Woolen industry, the Monarchy embarked, in 1217 A.D. on an "industrial policy" to clear forest lands and convert them into sheep pastures. Sherwood forest, home to a certain Robin Hode, was one of the forests selected for conversion. The forest was the "habitat" so to speak, of many who exploited its game and other resources in a natural manner not very different from contemporary swiddeners. Needless to say, many of these people resisted these royal incursions which as undisguised macroparasitic enterprises, took from the poor and gave to the rich. Many of these resisters, one of which was Robin Hode, came to be represented in the many manifestations of the Robin Hood legend [Sale 1995, p. 2]. But, contrary to the conventional assertion that Robin Hood "stole from the rich and gave to the poor," these guerillas were only trying to prevent the rich from stealing from the poor!

In the 14th century, the construction of Windsor Castle consumed 4000 Oaks [Gimpel 79]. Pope Pius II, while visiting Scotland remarked that the country was "destitute" of wood to burn. England began importing timber for shipbuilding from Russia and Scandinavia in the 17th century. Later in the same century the English had to build all of its naval ships in North America in order to get New Hampshire's Timber [Ponting p. 278-79].

Similarly, the English wreaked ecological havoc on Ireland's forests. According to Arthur Young, a literary traveler, in 1776, "the greatest part of [Ireland] exhibits a naked, bleak, dreary view from want of wood, which has been destroyed for the century past with the most thoughtless prodigality."

Before humans arrived in Ireland, some 8000 years ago, more than two-thirds of the Island was densely forested. The deforestation did not begin until the Tudor armies invaded in the 16th century [Solnid p. 46]. The forests of Ireland were just another of her resources that were "recklessly plundered" by the English. "Forests of oak were hastily destroyed for quick profits: woods were cut down for charcoal to smelt the iron which was carried down the rivers in cunning Irish boats...the last furnace was put out in Kerry when the last wood had been destroyed. Where the English adventurer passed he left the land as naked as if a forest fire had swept over the country [Morton p. 262]. By the 17th century, so devastated were her forests, Ireland was forced to import timber. By 1800 only 2% of Ireland remained forested. Today, Ireland is the least forested country in all of Europe [Solnit p.46]. Responsibility for this ecological catastrophe falls solely on the shoulders of the English, one of whom, a Sir Jonah Barrington, expressed the view that Irish trees were an "excrescence provided by nature for the payment of debts." The timber of Ireland was in great demand by an England and Europe that had already stripped their lands of trees. The profits of the cutting of timber went to the English. Jonathan Swift early in the 18th century noted both the "prodigious quantity of excellent timber cut" and the "little advantage to the country" of Ireland [quoted in Solnit p. 46].

The deforestation of Ireland was executed for purely pecuniary reasons, but it did generate some political benefits. The indigenous Irish revered the forest, the animals in it and

the natural world in general. The forests were a communally-owned “commons,” the use of which was closely regulated and special fines were imposed should one cut down a single tree. The forest, of course, was a source of wild game and it provided the foraging ground for the Irish “porkers.” With the loss of the forests the Irish were forced to alter their subsistence infrastructure from nomadic pastoralism to sedentary agriculture making them much easier exploit as sharecroppers or agricultural labor [Sonit p. 46]. Moreover, the loss of the forest “stripped rebels and outlaws of their cover” taking away a major strategic element for the Irish who fought using guerilla tactics [Solnid p. 46].

England was not the only European nation suffering from a shortage of timber. To build the Spanish Armada, Philip II had to buy wood in Poland. The Portuguese had to build their ships in Bahia, Brazil [Ponting p. 278].

Aside from the demand of ship building forest were cut for many other purposes. Millions of acres of forests were cleared to make pasturage and arable land [such land was called *essart*]. More important, "Timber was the main raw material of the time" [Gimpel 75] Timber was needed for the construction of water mills, windmills, bridges and military installations, casks for water and wine, houses, looms and other medieval machinery, and of course, cooking and heating homes.[Gimpel 75]. Timber was also the preferred fuel for cooking, heating and industry.

The iron and glass industries used forests to fuel their furnaces. These industries located in forests to be near their fuel supplies. In 1475, in the Rhineland, the iron industry created employment for 3000 miners to dig the ore and for about 5000 woodcutters to cut trees to produce charcoal for smelting. In the US the average blast furnace ate up about 250 acres of forest each year [Ponting p. 277]. The Scottish salt makers burned enormous quantities of wood to boil and evaporate salt water. Salt was the only means of preserving food before the invention of refrigeration [Long p. 8]

The only institution acting toward conservation of forests was the Royal Hunting preserves. But over time, financially pressed sovereigns sold the timber rights. By early in the 13th century England was importing wood from Scandinavia and Germany [Gimpel 80].

In the 13th century the limited use of coal began in industries from baking to black-smithing to dying and brewing. The iron industry did not convert to coal for technical reasons so had begun to decline by the 18th century due to a shortage of charcoal [Wilkinson 116].

It is to be stressed that coal was not used because it was a better fuel. Wood, the preferred fuel was becoming scarce and therefore expensive. Charcoal prices increased 65% between 1560 and 1630 by 150% over the next four decades. By the third decade of the 17th century, charcoal was so expensive England found it cheaper to import armaments from Sweden. Many iron furnaces in England had to shut down for lack of charcoal [Ponting p.281]. The use of coal presented technical problems to the industries that used it, and to the people in the vicinity of its use. It was centuries before the technical problems presented by new chemical interactions would be overcome. Bakers had to redesign their ovens. Coal was not used in iron production until late in the 18th century when several technological bugs had been worked out.

The coal, called sea coal, was mined in open pits 20 to 50 feet deep. It was said to be unsafe to walk around Newcastle at night because of the chance one might fall into one of these open pits [Gimpel 81]. Coal became a major industry for England. England was exporting coal to Belgium and France by the 14th century.

Sea coal began to pile up in London in the 13th century. London exported hides, tallow, meat, fertilizer, wool and other products to Scotland and Ireland, but the ships often returned without cargo. The Captains, confronted with the stormy seas around the English coast, would load their ships with sea coal as ballast. Upon arrival at London the coal would be dumped and soon accumulated into “worthless mounds of dusty, black rock” that “clogged city streets, docks and alleys” [Devra Davis, *When Smoke Ran Like Water*, 2002, p. 33]. Today the London street names Seacoal Lane and Old Seacoal Lane remind one of this period [Davis, p. 33]. These streets are in Ludgate Circus which was an early center of fertilizer manufacture. One of the first uses of seacoal was in burning limestone to make fertilizer and cement [Davis, p. 33]. Foundries were soon using it to smelt metals and, despite Royal proclamations banning the practice, and despite the “foul smokes and smells,” by the 14th century Londoners were using sea coal indoors for heating and cooking. Indeed, despite the multitudinous “inconveniences” of burning coal noted by the contemporary essayist, John Evelyn, including “cattarhs, phthisicks, coughs and consumption,” “practical needs prevailed” [Devera Davis, 2002, p. 35]. Wood, the fuel used before sea coal was now scarce.

England being a small island could not support large areas of forest. This “unique geography” at once “deprived its people of forest,” but, at the same time, provided England with coal. More importantly England’s geography made the transportation of coal relatively easy:

The land is flat, the rivers numerous and navigable , no town lie farther than 60 miles from the sea. The small land area made it possible to transport coal before an efficient transportation was devised to transport it...it is difficult to imagine how a mountainous and relatively landlocked country, even one like China with an abundance of coal, could have produced the world’s first industrial revolution [Long p. 8].

It is to be stressed that coal was not used because it was a better fuel. Wood was becoming scarce and therefore expensive. Charcoal prices increased 65% between 1560 and 1630 by 150% over the next four decades. By the third decade of the 17th century, charcoal was so expensive England found it cheaper to import armaments from Sweden. Many iron furnaces in England had to shut down for lack of charcoal [Ponting p.281]. The use of coal presented technical problems to the industries that used it and to the people in the environs. It was centuries before the technical problems presented by new chemical interactions would be overcome. Bakers had to redesign their ovens. Coal was not used in iron production until late in the 18th century when several technological bugs had been worked out.

The use of sea coal brought with it the problem of air pollution - the “smokes and stinks” John Graunt notes as extant in 1662. Thus, air pollution also preceded the “industrial revolution.” The inferior quality, surface mined coal, gave off “a continuous cloud of choking foul smelling, noxious smoke.” In 1257, the Queen of England left the town of Nottingham complaining of the noisome fumes [Gimpel 82]. By the end of the 13th century London had

achieved the distinction of being the first city to pollute its air to the point it became a threat to "bodily health." A royal proclamation banning the use of sea coal in London, issued in 1307, seemed to have little effect [Gimpel p.83]. By 1615, over four hundred British ships were regularly engaged in the transportation of coal, half of these were needed to supply London alone [Long p. 8].

In 1661, the King requested John Evelyn prepare a plan to ameliorate the bad air over London. In his report he noted that while the fumes from "culinary fires" are a problem, he emphasized that the various industrial "funnels and issues [smokestacks]...manifestly infest more air than all the chimneys of London put together" [quoted in Durant 1963 p. 260].

To Evelyn these industrial smokestacks made London appear more like "Mt. Etna...or the suburbs of hell, [rather] an assembly of rational creatures... The weary traveler... sooner smells than sees the city [quoted in Durant 1963 p. 260]. Evelyn notes further that the coal soot has more than merely aesthetic consequences:

The acrimonious soot ulcerates the lungs, which is a mischief so incurable that it carries away multitudes by languishing and deep consumption, as the bills of mortality weekly inform us [quoted in Durant 1963 p. 260].

To make matters worse, another commentator complained that a "mist and fog" caused by "exhalations of sewers and fetid places and decoctions used by unwholesome and sordid manufactures" combine with "coal smoke" to produce "catarrhs⁷ and coughs" and a multitude of other "bad effects" [Durant 1963 p. 261].

London and other cities also suffered from water pollution. First, the particulates from the burning of coal found their way into the water raising its acidity and killing fish. Second, slaughter houses and tanneries filled the rivers with gore and chemicals:

dried blood, fat, surplus tissue, flesh impurities, and hair were washed away with acids and lime into the streams running through the cities.[Gimpel p.86]

Laws were passed forcing tanneries and slaughterhouses to move outside and downstream of the city of Paris. In 1388 the English Parliament passed the first national antipollution act directed at both air and water pollution.

By the 16th century the shortage of timber had become acute. Between 1500 and 1700 the general level of prices rose about 400%. The price of timber for firewood rose 950%. The quantity of firewood purchased with one hundred pounds in 1500 cost 1058 pounds sterling in

4. In England this term was used to describe a severe cold with influenza like symptoms. In the United States it refers to an inflammation of the mucous membranes of the nose.

1702.[Wilkinson 114]. Despite its noxious side effects and “intolerable smell” the use of coal expanded and gradually the pit mining techniques gave way to deep underground mining. It was the problem posed by mining below the water table that led to the “invention” of the steam engine.

Coal mining was an “equal opportunity job.” For the first 500 years of British coal mining, men, women and children toiled in the mines. The first coal pits were mined by serfs organized as families. The serf families, men women and children dug coal as team [Long p. 9]. After the end of serfdom, miners toiled under annual contracts. However, compared to the life of Scottish miners the English were more “free.” Scottish miners who left their “masters” without permission were considered “thieves of themselves” and subject to severe punishment [Long p. 14]. Scottish mine owners had the right to seize vagabonds and their families and compel them to work in the mines for life. “Coal owners bought and sold the mining people with the collieries (mines), inventorying them on bills of sale” [Long p. 14]. The male children of miners and the ubiquitous orphans, entered the mines at about age “six, seven or eight.” The female orphans were left in the workhouses which, because of the extensive use of boys in the mines, were almost exclusively female [Long p. 16]. The children worked six days a week and 12 to 18 hours a day:

upon arriving home [the children] thrown themselves down on the stone hearth...fall asleep at once without being able to take a bite of food, and have to be washed and put to bed while asleep.... It seems a universal practice among these children the spend Sunday in bed to recover in some degree from the over exertion of the week [Engels, quoted in Long p. 16].

The children worked underground, in bad, hot, dust-filled air with only “bread and cheese” to eat. “The children grew up crooked and physically deformed. The girls soon became as rough and uncouth as the boys, fighting and swearing like them, and many bastards were born in the colliery village” [Long p. 16].

When girls were older they worked in the mines, with their mothers as haulers of the coal hewn from the seam by their fathers and brothers. Women carried a heavy burden often 150 to 200 pounds of coal at time, in baskets attached to their backs, and about two tons per day [Long p.17]. In 1808, one chronicler observed:

The mother sets out first, carrying a lighted candle in her teeth; the girls follow, and in this manner they proceed to the pit bottom, and with weary steps and slow, ascend the stairs, halting occasionally to draw a breath, til they arrive at...the pit top, where the coals are laid down for sale, and in this manner they go for eight to ten hours, almost without resting. It is no uncommon thing to see them ascending the pit, weeping most bitterly, from the excessive severity of their labor; but the instant they have laid down their burden on the hill they resume their cheerfulness and return down the pit singing [Long p. 17]

By the 19th century women were attached to coal cars like beasts of burden and on their hands and knees they dragged the carts full of coal along the narrow tunnels which were usually

flooded with several inches of water and were incredibly hot⁸, sometimes hot enough to melt candles [Long p.17]. When the good Victorians saw the wretchedness of women's lives, the banned the employment in 1842 of women in the mines. Many single women were barred from their only means of livelihood so surely some resorted to prostitution. Many families in desperate need of the mother's and daughter's wages fell into destitution [Long p. 17].

Mining was a hazardous occupation for both men and women. Miners were crushed under cave-ins, or they fell down the shaft. The greatest danger in mining came from explosions of what miners called "firedamp" - methane. Methane is naturally emitted from the coal as the tunnels are cut through the seams; the lower pressures in the tunnels produced a "gradient" and the methane oozes out. Naturally, an open flame is a real hazard in a mine. Methane, however, is odorless. Experienced miners can tell by watching the color of the flame whether methane is present, but often the recognition comes too late. Mine explosions were frequent. The Davy safety lamp encased the flame in wire mesh to separate it from the gas, but it made matters worse. With the safety of the lamps the ventured deeper into the ground and into areas where gas had earlier precluded mining. After the invention of the safety lamp mine explosions increased! [Long [p.18]. One might asks why miners would take such risks. In his novel *Germinal*, Emile Zola, explains that miners had to take risks to get enough coal to earn wages sufficient to sustain survival.

In the fictional *Le Voreaux* mine, workers were expected to shore up the mine tunnels with timbers. The miners, however, did an inadequate job, greatly increasing the risk of a cave-in, because they could not afford to take time away from hewing coal. The price they were paid for coal was so low the one hour per day lost shoring up the tunnel meant the difference between eating or not eating. Death in a cave-in was a probability, death through starvation was a certainty.

Another mining hazard was carbon monoxide (CO) another odorless gas and silent killer. Carbon monoxide bonds with hemoglobin, crowding out oxygen. When one breathes it, one just goes to sleep and dies. Miners carried canaries into the mines as "CO detectors;" when the canaries died the miners cleared out.

Mining is very dangerous and dirty work carried-out under the most horrific conditions, yet the wages of miners were so low, the earned barely enough to eat. The inequity of such hard work for such low wages, while others lived well by not working at all, led John Stuart Mill to advocate Communism:

If, therefore, the choice were to be made between communism with all its chances and the present state of society with all its suffering and injustices; if the institution of private property necessarily carried with it as a consequence that the produce of labor should be apportioned as we now see it, almost in an inverse ratio to the labor - the largest portion going to those who have never worked at all; the next largest to those whose work is almost nominal, and so in a descending scale, the remuneration

4.As coal shafts went deeper the mines warmed because the increasing pressure of the land above on the coal and the rock produced heat. Remember the basic formula $Pressure \times Volume / Temperature = constant$. As pressure applied to a constant volume rises T must rise.

dwindling as the work grows harder and more disagreeable, until the most fatiguing and exhausting bodily labor cannot count with certainty on being able to earn even the necessities of life; if this or communism were the alternative, all the difficulties, great or small, of communism would be put as dust in the balance [quoted in Laidler p. 180].

The socialists located the root of this exploitation of workers in the institution of private property, especially in natural resources, which allowed some to live without working. Mill insisted that the “rule that they who do not work shall not eat” should be applied “not to paupers only, but impartially to all.” In the case of coal, as it is the miners that do the work, to the miners should go the rewards. However, private ownership of coal mines, allows some, who probably inherited this ownership, to live in idleness while the miners starve. Professor Cairns, a contemporary of Mill, wrote:

It is important on moral no less than on economic grounds to insist upon this, that no public benefit of any kind arises from the existence of an idle rich class. The wealth accumulated by their ancestors and others on their behalf, where it is employed as capital no doubt helps to sustain industry; but what they consume in luxury and idleness is not capital, and helps to sustain nothing but their own unprofitable lives. By all means they must have their rents and interest, as it is written in the bond; but let them not take their place as drones in the hive, gorging at a feast to which they have contributed nothing [quoted Laidler p. 182].

English Socialists of the 1880s, like Cairns and Mill, did not advocate the revolutionary path posited by Marx and Engels. The condition of the English working class had greatly improved since 1850. Many workers now had access to the ballot box, many were in Unions and in cooperative societies. The demand for violent revolution had vaporized and reformist, legislative strategies had taken its place [Laidler p. 183]. In France socialism took a different path. Here the emphasis was on syndicalism, a system where workers establish and protect their rights through the trade and industrial unions. The Syndicalists eschew both violent revolution and ballot box politics. Working class interests are, instead, advanced through general strikes and other forms of direct action [Laidler p. 277].

Water, water everywhere...

At first mines were “quarries;” the coal was dug from the surface with wooden shovels, but eventually the demand outstripped the surface supply forcing miners to sink deep shafts into the ground. By the early 1700s shafts ranged from 200 to 500 feet deep and by 1800 one shaft was 993 feet deep [Long p.9]. The sinking of these mines to such depths presented a number of substantial technological problems.

When mines were dug below the water table they fill up with water so some sort of pump is needed. If the mine happened to be shallow and near a river a mill driven rag & chain or bucket pump or horse powered pump could be used. But in deeper shafts even bucket pumps operated by 500 horses proved inadequate. Suction pumps could lift water no more than

thirty feet [Long p. 9]. But as mines got deeper all these methods failed because the energy required to both lift the water and to overcome the friction of the machinery could not be produced by these technologies [Wilkinson 118]. In 1699, Thomas Savery patented an invention, a simple steam engine, he called the “miner’s friend” The steam pump worked because it reduced mechanical inefficiency by reducing the number of moving parts. The pump worked simply by forcing steam into a chamber full of water, thus forcing the water out. As the steam condenses, and pressure falls, more water flows in and the process is repeated. The only moving parts are the valves that prevent water ejected from returning, and to allow new water to enter the chamber. But, Savery’s engine was not able to raise water more than twenty feet so was of little use in the deeper pits Thomas Newcomen improved on Savery’s design by adding a steam driven piston encased in a cylinder. The piston was driven up with steam pressure, and then down by condensing the steam with a spray of cold water, creating a vacuum and allowing atmospheric pressure to drive the piston into the vacuum. The Newcomen engine was inefficient, it converted only 1% of the coal energy used into pumping energy, and, thus, required vast quantities of coal to produce the steam that drove it. For economic reasons then, it’s use was restricted to coal mines where coal was readily available⁹ [Long p. 11]. Even considering its inefficiency, however, the Newcomen engine did the pumping work formerly done by 20 men and 50 horses [Rothschild p. 25]. On balance the cost of keeping a mine clear of water fell some 40% with the introduction of the Newcomen pump.

The Newcomen engine was greatly improved by James Watt. Watt added a condenser to the Newcomen engine which made it much more energy efficient.¹⁰ The Watt engine could deliver the same power with 75% less coal. Watt began production and sales of his engine in 1775. In 1784 Watt developed an engine that could produce rotary power such as needed to drive textile mills. Factories were no longer constrained to locate along side streams with swift currents [Rothschild p. 27]. The Watt engine was first used to power a cotton mill in 1785. By 1850 the steam engine almost completely replaced water power as a source of energy for the mills [Dillard p. 245].

Undoubtedly the steam engine was the greatest technological advance of the 18th century, but, technological change does not occur in a vacuum. The first model of a steam engine was made in 100 B.C.[Dillard p.243]. The full development of the use of the expanding power of steam had to await the specific circumstances of 18th century England when and where the steam engine was ecologically favored [Dillard p.243]. Animal power was expensive as a land shortage drove up the price of fodder. Also sites along rivers for mills were all used up long before the 17th century [Wilkinson p.120-21]

People Fuel

⁹Actually, the mines used small pieces of “scrap” coal that had no market value [Rothschild p. 25].

¹⁰Newcomen’s design had cold water sprayed into the piston cylinder to condense the steam. The cold spray also cooled the cylinder. Due to the need to reheat the cylinder in each cycle much energy was wasted. By adding a condenser separate from the cylinder Watt’s design avoided this problem [Rothschild p. 27]

In earlier lectures I have pointed out that the industrial revolution was an energy revolution. Both machinery and factories had been "invented" several centuries earlier. For example, machines such as water-powered mills were extensively used as early as the 10th century. Iron and glass smelting were well established by the 13th century. Agriculture had advanced from using exclusively human energy to oxen to horses along with gradually improved plows.

The Industrial Revolution was an energy revolution because it was driven by steam power derived from coal and applied to machinery. It was also dependent on increasing the amount of energy available to workers.

Factory production involved long hours of very intensive labor compared to rural peasant life. The first law of thermodynamics asserts that energy output from a machine cannot exceed energy input. Thus, if an employer needs a certain amount of work energy the worker-machine will have to be fed at least that amount of calories. As workload rises so must caloric intake. Between 1400-1600 the average English farmer-miner worked 1980 hours per year. By 1840, the hours of work for the average English worker had risen to between 3100-3588 and 50% increase [Schor p. 45]. A dramatic improvement in worker nutrition was necessary to supply the energy necessary for the greater workload. In short, the industrial revolution required a greater capture of solar energy in the form of that captured from the current solar flux (plant foods) and that saved and endowed by past solar flux (fossil fuels).

During the 18th and 19th centuries Europeans were, if measured by modern standards of weight and height were "stunted;" the average Englishman was 5'6" tall and weighed in at about 135 pounds.¹¹ The diminutive stature of the 18th century European is a direct consequence, not of genetic factors, but of simple malnutrition. As we saw in an earlier chapter one way the human body responds to long-term food shortages is to not to be as large so as not to need as much food for maintenance. The contemporary American male needs 2,279 kcal to maintain basal metabolism and to digest food [Fogel p. 372]. If the 18th century British worker had been as large as the typical American male today, then virtually all of the energy produced by his food supplies would have been required for maintenance, and hardly any would have been able to sustain work [Fogel p. 372]. Even allowing for diminished stature however, if the quantity and intensity of work are to be increased, more calories must be added to the diet. Robert Fogel estimates that most poorly nourished 20% of the English population, at the onset of the industrial revolution, had barely enough energy left over after maintenance for a "few hours of strolling" or less than two hours of heavy work per day [Fogel 1994 p.373, p.386]. Those better nourished were not much better off- in 1790, 30 years into the industrial revolution, 70% of the English population¹² consumed less than 2800 calories per day [Fogel p. 374 Table 2]. But the English diet, especially in the rural areas did improve. After 1720, and increasingly so, markets were filled with higher quality meat, vegetables, sugar and the

¹¹ The average contemporary American male is nearly 5'10" and weighs 172 pounds [Fogel 1994 p.372].

¹² Remember that these figures include the affluent. The top decile consumed 4,329 kcal per day, but they were probably not workers.

"miracle food," the potato. The substitution of meat and sugar for grains increased the percentage of ingested energy that can be metabolized into energy available for work. Moreover, the overall improvement of health reduced the amount of energy that is needed to fight disease [Fogel 1994 p.386]. Not surprisingly, after 1720, population growth rates exploded.

The industrial revolution required a better fed population to realize the greater quantity and intensity of work it generated. Where did the food come from?

The Growth of Agricultural Productivity

Fundamentally, the growth in English agricultural productivity rested on social, political, and technological factors. Indeed, were it not for the social and political revolutions peculiar to England it is unlikely that the technological changes that spurred agricultural productivity would have happened. Consequently, it is unlikely that the Industrial Revolution would have happened when it did. In England the *Bourgeoisie* seized power a full century before its counterpart in France did. Even when they did seize power in 1789 the French Bourgeoisie pursued land reforms that were exactly the opposite of those pursued in England. Whereas, in England land tenure law (Acts of Enclosure) was established to drive the small independent farmer into extinction,¹³ in France the revolution established the independent farmer into a solid economic and political entity that persists to this day. In France, the bourgeoisie needed the peasants to protect the revolution from reactionaries, both foreign and domestic. In England on the other hand the peasants sank into "political insignificance":

The Revolution of 1688, which brought to the conclusion the constitutional struggle of the seventeenth century, was accomplished without their [the yeomanry] aid, and paved the way for their extinction. A revolution in agricultural life was the price paid for political liberty [Toynbee p.34].

In England the process of enclosure propelled by the "self-seeking action of the dominant class" has been recognized as one that produced "gross social injustice" [Toynbee p. 31] But ironically, it did ultimately raise the productivity of agriculture and even more ironically it was produced by the same "system of political government"¹⁴ which made [the English] a free people" [Toynbee p. 31]

In England land came under the control of the *Bourgeoisie* who brought to the manor a

¹³ Toynbee notes that there were 180,000 freeholders in England in 1700. By 1760 they were "practically gone." The disappearance was so complete, Toynbee notes, that one "might surmise that a great exterminatory was had taken place" [Toynbee p. 32].

¹⁴ Parliamentary rule by the Bourgeoisie displaced the rule of the absolutist monarchy in the Glorious Revolution of 1688. Toynbee writes "the distribution of landed property in France and Germany which writer after writer points to as the great bulwark against revolution, is in the main due to a form of government that destroyed political liberty and placed people in subjection to the throne [Toynbee p. 31-32]

capitalistic mentality that drove them to use the land as they did their capital, to produce profit [Cole p.422]. The merchant bourgeoisie had amassed great wealth in commerce, but the English social structure granted social status only to landowners. Thus emerged "a new race of landowners" and "hence the mercantile origin of much of our nobility" [Toynbee p. 35].

The new "nobility" began to accumulate land at a prodigious rate when they arranged laws, "in a most iniquitous manner" that allowed the enclosure of common pasture and waste lands that denied the freeholder of his traditional rights. Without these traditional assets (for pasture and firewood etc) the freeholder "found it much more difficult to pay his way" and finally was forced to sell his land for a pittance [Toynbee p. 37]. By 1851, more than half (4/7) of the land in England was owned by a mere 4000 proprietors. That land was farmed by 250,000 farmers who, in turn, employed 1.25 million workers and servants [Hobsbawm p. 150].

"In no part of Britain were...innovations adopted on such a scale as to make it possible to speak of an agricultural revolution, or an agrarian revolution" writes T.S. Ashton [Ashton p. 28], nevertheless the capacity of England to produce food in the 18th century nevertheless expanded faster than the growth of the population and thus allowed living standards to rise [Ashton p. 6]. The rise in productivity was due to many specific factors, but generally speaking it was the result of bringing agriculture into the capitalist orbit. It took capital (money) to introduce new equipment, to experiment with new techniques, to drain land and build better barns [Cole p.421-22]. The profits of "the enslavement and entombment of aboriginal populations" and "hunting for black skins" found yet another outlet.

There was first of all an increase in the amount of land brought under cultivation realized by draining the fens and marshes and by turning common pasture into arable land through enclosure. In each case people were dispossessed, but as one commentator observed, "more useful territory was added to the empire, ...than had been gained in every year since the revolution [Ashton p. 7].

The earlier enclosures were directed toward turning arable into pasture land. 18th century enclosures transformed communally cultivated "open fields" into large contiguous plots more amenable to large scale scientific farming [Morton p. 327]. This type of enclosure raised agricultural productivity because it brought an end to the old "open field system" where the land was divided into strips and farmed on a small scale, by many individuals. Once enclosed the land could be farmed on a more efficient, larger scale [Cole p.423] Altogether some 4 million acres were enclosed between 1717 and 1820 [Morton p. 327].

Enclosure, proletarianization and women

Enclosure was integral to the creation of the working class, that is, the class of people, who, lacking any alternative means of subsistence, sell their labor for wages. Without an expanding labor force both the expansion of commercial agriculture and industrialization would have been impossible. Enclosure was socially significant because it made families more dependent on wages and women more dependent on male wage earners. Because of the necessity of nursing their children, women were not available for factory work, or work on industrial farms except in peak periods for short durations of time. Since many men were semi-proletarians, that is, they sold their labor for wages for some parts of the year and worked the

“commons” for the rest, the bulk of the exploitation of the commons was in the hands of women [Humphries p. 21].

The commons provided people with economically valuable rights which could equal in value over the course of the year what a man could earn in wages. Common “rights” included the right to graze animals, to gather wild foods, to gather fuel and wood for construction and to “glean” the remainder of crops left behind in the harvest of private land.

Marx emphasized the historic importance of enclosures in the creation of the making of the English proletariat. But anti-Marxists have minimized their role on the grounds that the use of the commons produced little of value. Thus, historian J.D.Chambers wrote, that the product of the commons was little more than the “trifling fruits of overstocked and ill-kempt lands” [Humphries p. 21]. Another commentator viewed women’s exploitation of the commons with a “condescending sneer;” “miserable productions and trifling employments” he called the efforts of women to make brooms from heath and the gathering of berries [Humphries p. 32]. Hence, from this perspective at least, the costs of enclosure were surely greatly exceeded by the benefits and, given the burgeoning English population and the need for more efficient food production, the forwarding of enclosures was asserted to warrant the “strenuous endeavors of every friend of mankind”[Joseph Plymley, 1813 quoted in Humphries p. 22]. Nevertheless, the access to the commons substantially increased the well-being of those poor cottagers who exploited it. The benefits of enclosure, then, while no doubt substantial, were nonetheless, highly “skewed” toward the better-off and the costs similarly skewed toward the poor [Humphries p. 22].

Grazing rights on the common were almost as valuable as a weeks wages [Humphries p. 24]. The butter, calves, and skimmed milk provided by the ability to keep a cow had a value that, while less than a man’s annual wages was significant. The skimmed milk spelled the difference between well and poorly nourished children and a varied vs a monotonous diet (milk made potatoes more palatable)[Humphries p. 25]. The right to gather firewood and to glean also added to the well-being of the poor people. During the gleaning period, about a month, a woman might gather only several bushels of wheat, but at the inflated market values of the time, this was not insignificant - it was about equal in monetary value to her husbands wage earnings for the month [Humphries p. 35]. The gleaning of bens and barley for example allowed the poor to keep animals such as pigs.

Access to the common increased family well-fare because there was little “opportunity cost in doing so. The semi-proletarian male could devote most of his time to earning market wages while his wife and children could exploit the commons. The industrial and workshop regimes of the time provided no “spontaneous pauses in which to nurse” so babies and wage work were incompatible. “Wive and mothers thus found it increasingly difficult to participate in the ascendant mode of work” [Humphries p. 36-37].

Thus, a degree of specialization emerged where women exploited the commons and their husband's were exploited in the labor market. As one contemporary observer put it, this arrangement seemed ideal as:

The employer gained because the cow-keeping cottagers ate better and so worked harder for the same wages...Society at large benefitted by usefully filling the spare time of the laborers [who] when the have spare time go off to their land and their stock rather than to the ale house; and the women employ many hours in the care of their cows and dairies, which would be otherwise worst than lost in idleness and gossip [quoted in Humphries p. 39].

There is direct evidence that it was women specifically who exploited the commons. Women exploited common grazing as an alternative to charity, the poor law, or burdening their children. The widow and her cow were probably as common in reality as they are in fairy tales...

Widows traditional recourse to cowkeeping was even insitutionalized as a public panacea to feminized poverty. The guardians often purchased cows for older women to try to keep them off the rates. But, for the cow to be the functional equivalent for social security, continued access to the common land was required [from Jane Humphries.1990 p. 39].

In addition, to the addition of land by reclamation and enclosure land supply was effectively increased as new crops were introduced. The turnip proved to be excellent winter fodder for livestock [Cole p. 427]. The turnip thus permitted larger herds of cattle and allowed farmers to keep their animals over the winter months rather than slaughter them. Keeping more animals all year provided more fertilizer. It also provided milk all winter [Burke p. 173]. With regular feed rather than haphazard grazing both sheep and cattle grew in average weight. In 1710 the average weight of sheep and cattle was 28 and 370 lbs. respectively. Just eight decades later it was 80 and 800 lbs. respectively [A.L. Morton 1938 p.326]. Moreover, the cultivation of the turnip thus freed land that was previously held as pasture for cultivation [Ashton p.28]. The turnip is quite deserving of the title the "wonder crop" of the 17th century [Burke p.172].

Fortuitously, the weather also improved during the 18th century, at least compared to the earlier century. The "little ice-age" is marked as the period 1430-to 1850 [Ponting p. 99]. However, the period from 1680 to about 1730 showed a dramatic increase in temperatures. Although they fell again in subsequent periods temperatures remained above those that had obtained in the 15th, 16th and 17th centuries. The most important manifestation of the warmer climate was a shorter and milder winter [Ponting p. 99]

The Transportation Problem

As trade expanded the transportation problem became more acute. Wagons carrying ever more heavy loads (especially of coal) were taking a toll on the dirt roads. Daniel Defoe, wrote in 1724, that "the roads are packed, over-used and ruined." [quoted in Burke p.178] The

roads had so deteriorated that pack animals were becoming popular [Burke p. 178]. Legislative attempts to control loads and wheel widths failed. A way had to be found to build and maintain roads. The toll road trust was the device used. People would have to pay to use the road. Instituted by the early 18th century, surfacing innovations soon followed by men like Telford and McAdam [Wilkinson p.122] An extensive system of canals was another response to the transportation problem, especially that of bulk shipments like grains and coal. But, even the canals required horsepower to pull barges and horsepower was becoming more costly.

As we have seen, under the pressure of a growing population land was becoming very scarce. Yet, it took as much as 8 acres of land under hay to feed a single horse. The land necessary to feed a single horse could feed eight men [Wilkinson p.124]. One estimate (based on 4 acres per horse) put the number of horses in England at 1,350,000 and the amount of land to feed them at 5,400,000 acres. Another commentator estimated that the canal from London to Cambridge would release 1000 horses from employment and free 8000 acres of land "for more useful purposes, which would help the laboring poor from suffering from want of bread [Wilkinson 124]. Wilkinson asserts that were it not for the high price of horse feed the canals would not have been profitable:

Only when competition for land had forced the prices of horse feed sufficiently high was it worth expending labor on the construction of canals which allowed larger loads to be drawn by fewer horses [Wilkinson p.124].

Similar calculations made the development of the steam locomotive profitable. One report estimated steam locomotives would replace one million horses and allow for an addition human population of some eight million souls [Wilkinson p.125]. The horse would remain only as personal transportation and in that role it would be soon replaced by the bicycle and the automobile. It was not until there were no sites left where textile mills could be run on water power, that the traditional symbol of the industrial revolution, the steam powered textile mill, using the designs of Bolton and Watt was established.

The industrial revolution accelerated not because of the spontaneous invention of the steam engine, but rather because the ecological problems caused by an expanding population became more acute:

The formidable group of innovations should not be regarded as the fruits of a society's search for progress, but as the outcome of a valiant struggle of a society with its back to the ecological wall [Wilkinson 126].

Living Standards

In GH societies and other preindustrial societies we have seen that people tend to limit the amount of work they do that required by the minimum necessity of subsistence. Economists say these people manifest as "leisure preference" [Wilkinson]. We know that as the mode of production changed from GH to Swidden to Agriculture that workloads increased substantially. You should not be surprised to discover that the industrial revolution increased

workloads also. Indeed, economist Juliet Schor claims **"there is good reason to believe that working hours in the mid-nineteenth century constitute the most prodigious work effort in the entire history of humankind"** [Juliet Schor, *The Overworked American*, p.44].

Compared to the medieval period work hours increased 50% under industrial capitalism, which amounts to about 1000 hours per year (3105-1988) or 20 hours per week.

In the medieval period, in agriculture, one worked from dawn to dusk (16 hours in summer 8 in winter). But work was intermittent - interrupted with breakfast, lunch, the customary afternoon nap, and dinner and mid-morning and mid-afternoon refreshment (not coffee) breaks. These hours usually applied only at harvest times; in slack periods hours were drastically reduced. The pace of work was also much slower, there was no consciousness of time (as we know it) and it had much less economic value. We had yet to reach the age where time became money. Also the medieval calendar was filled with holidays that gave vacations of several weeks (Christmas, Easter) or several days on the local Saint's day. All together these holidays consumed about 1/3 of the year [Schor, p. 47]

There were also simple biological constraints on the amount and intensity of work. Indeed, given the limitations imposed by the caloric intake of the typical peasant, sustained hard work was not possible. Indeed, as diets improved after the industrial revolution all of the extra calories were burned up by more intensive work [Schor p.46]. Thus, a great part of the increase in productivity associated with the industrial revolution can be accounted for by increased hours and intensity of work. One might ask then. "What did the workers get for their increased efforts and hours?":

By the 1800s factory hands and miners were putting in 12 hours a day under conditions that no self-respecting Bushman (Kung!), Trobriander, Cherokee, or Iroquois would have tolerated. At the days end, after contending with the continuous whine and chatter of wheels and shafts, dust smoke, and foul odors, the operators of the new labor-saving devices retired to dingy hovels full of lice and fleas. As before only the wealthy could afford meat. Rickets, a new crippling disease of the bones caused by lack of sunshine and dietary sources of vitamin D, became endemic in the cities and factory districts. The incidence of tuberculosis and other diseases typical of low-grade diets also increased.[Harris 1978 p. 275-76].

Even worse, just like their stone age ancestors, the new working class had to murder their children to protect their by now much more meager standard of living. The lives of children had indeed become cheap as their parent gained less for the killing of them. In addition, to death by "overlaying":

unwanted children were also drugged to death with gin or opiates, or were deliberately starved...it was not an uncommon spectacle to see the corpses of infants lying in the streets or on the dunghills of London...[Harris 1978 p.275]

Government Foundling hospitals were established to care for unwanted children, but under the relentless pressure of sheer numbers up against limited resources "they quickly became *de facto*

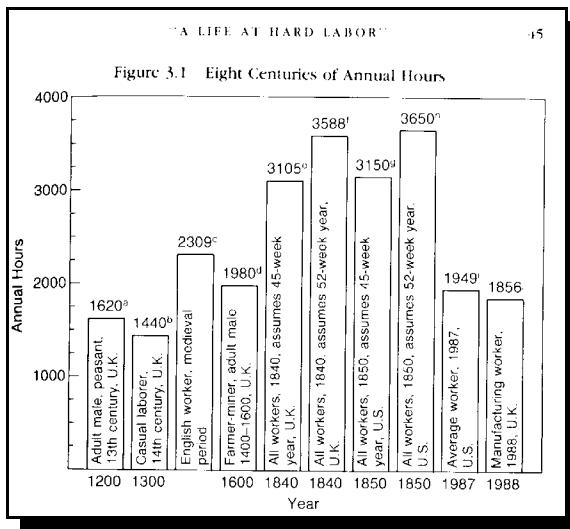
slaughterhouses." Of the 15,000 children admitted to London's foundling hospital between 1756 and 1760, only 4,400 reached adolescence [Harris 1978 p.275]. In France, the first year infant mortality rate in foundling was 80-90% compared to a normal rate of about 20%. The nurses who worked in the English foundling homes were called she-butchers.[Harris 1978 p.276]

When Europeans reached China and India they were shocked by the "wastage of human life," [Harris, Our Kind, p.1989] to infanticide, especially that of females. No doubt this barbaric behavior only further carved into the imperialist mind the notion that these people were backward and surely the "white man's burden." How conveniently narrow was their perception that they could ignore the extent of these practices at home in Merry Old England.

The real tragedy is that the children who were murdered may have been the lucky ones. The extensive use of child labor made it profitable to keep them alive. As Harris writes, they were given the "dubious privilege" of working for a few years in a factory before dying from tuberculosis. [Harris, 1978 p. 277].

Pauper children and orphans from poorhouses, orphanages and workhouses were regularly "bound out" or apprenticed to textile employers (to hold down the poor rates) as virtual slaves. They never left the factories, were treated brutally, fed poorly, and never paid a wage.

Owing to the fatigue of excessive hours they met with more accidents than was



usual in the operation of unguarded machinery; mutilated fingers and crushed limbs were common occurrences. They were poorly fed and hardly clothed at all, and they lived in filthy and overcrowded quarters. Those who survived...came out with bowed legs and crooked backs, as well as warped minds and vicious characters"[Dillard p.254].

In 1802 the British Factory Acts limited the working day of children to 12 hours. The system which exploited pauper children came to an end thanks to the steam engine. Pauper or captive labor was needed in only in rural areas at water-sited mills. The steam engine

facilitated the movement of the mills into population centers where there was a large supply of "free" children of poor parents. The employer now found it cheaper to pay a small wage and leave the general support of the child to the parents so "apprenticing" ended [Dillard 254].

In 1819 employment of children under 9 (employment at 5 was common) was prohibited. By 1833 the work week was reduced to 48 hours for children between 9 and 13. Those under 18 could not work more than 69 hours per week. In 1844, the protections offered to 13-18 year old children were extended to women. In 1847 the ten-hour day was instituted.

This series of regulations established a challenge to the laissez-faire position of the classical liberals. The unregulated labor market had severely harmed the working classes. The factory acts marked the first social protest against conditions created by the industrial revolution. Ironically, the workers had little to do with it. Workers had no representatives in parliament and could not vote. The cause of workers be they men, children, or women was taken up by the landed gentry as a way of opposing the growing power of the capitalists. The worker will eventually become engaged in protest in the form of unionism and political action.[Dillard 256].

Standards of living did eventually rise as productivity growth eventually outstripped population growth. Following the pattern of demographic transition death rates and eventually birth rates fell. But the full social harvest of the industrial revolution had yet to be reaped. In 1829 a new and unknown plague ravaged Europe. Its symptoms were severe diarrhoea, thirst, dehydration, severe pain in the limbs, stomach and abdominal muscles, a change in skin color to bluish gray and then death; it was called Cholera. It began in the Indian City of Calcutta in the Ganges Delta. After striking dozens of Asian and European cities, it arrived in England in 1831, in two years it took 22,000 English lives. But, the Cholera merely added to the abominable toll of disease that was now commonplace in Britain's industrial slums.

As people migrated into the industrial towns they were forced to live in "unhealthy, jerry-built dwellings" that could not be constructed fast enough to house the migrants. Since the housing had to be built close to the mills, builders, "crammed in" as many tenements as they could [Burke p. 222]. Living conditions soon became very crowded and very septic:

Many of the new tenements stood round a common court, an open space where stood the only well, often deep in undrained filth. The courts also housed herds of pigs living in their own dung. In the unpaved central area lay stagnant water, as well as waste and refuse thrown out of the windows for the pigs. People without accommodation lived in these open courtyards. In Liverpool, when cholera struck, no fewer than 60,000 people inhabited unprotected open spaces. Those who did so were only marginally worse off than the 40,000 who lived underground, sometimes twelve to a cellar, in conditions of unspeakable degradation [Burke p. 223].

The people living under these conditions were especially vulnerable to disease because they were malnourished and were driven to exhaustion by the long hours and unrelenting pace of work in the factories, which were also filthy and dangerous to boot. Damp conditions created and exacerbated rheumatic and respiratory problems. In the close quarters "contagion and incest were rife." Young women were perhaps indifferent to such exploitation after spending hours in the factory in "circumstances of brutality, debauchery and obscenity" where they often suffered the sexual harassment of their male co-workers and employers [Burke 224].

In a report, published in 1842, called *The Sanitary Conditions of the Labouring Population of Great Britain*, it was clearly demonstrated that "bad sanitation, polluted water supplies and filth" shortened the life-expectancy of English workers [Burke p. 228]. The report documented that while a man of the Gentry could expect to live to forty-three, and a tradesman to thirty, a worker could not expect to live past the age of twenty-two [Burke p. 229].

Nevertheless, aside from some concerns over the conditions of child labor, the English government continued to presume that the industrial revolution had brought benefit to all. Those who did not prosper could only blame themselves. It was the "nature and character" of the lower classes, their "ignorance and degradation" that prevented them from realizing some share of the benefit of industry [Burke p.226].

The Industrial Bubble.

The industrial revolution marked a significant departure from past practice for human economy. Up to the 19th century plunge into coal and oil, which are nonrenewable energy sources, humans had relied on renewable (at least theoretically - wood is renewable but no nation ever bothered) energy sources: wind, water, wood and, of course, human energy. Surely fossil fuels appear as plentiful as forest must have appeared to be in the 13th century and consequently they are being used, or should I say squandered, with the same abandonment of future orientation that was evident for wood. At the moment the average American consumes 350% more energy than in 1900. Americans while 5% of the world population account for 30% of world energy use. Meanwhile, about 100 million people are unable to obtain enough fuel for minimum cooking and heating requirements. At the rate at which forests are being depleted that number could be 3 billion by the turn of the century.

The industrialized nations do not use fossil fuel very efficiently. In China, traditional rice paddy agriculture produces 50 times more energy than it takes to produce it. Typically, "primitive" agricultural systems produce a 20 fold return on energy investment. At its very best, modern cereal farming produces about twice as much energy as it consumes in the form of pesticides, fertilizer and machinery, but efficiency is falling. The famous law of diminishing returns is quite evident. Energy inputs are increasing, but yields are increasing not nearly as much. Between the end of WWII energy inputs increased 400% but the energy yield increased only 138% [Ponting p. 292].

Some products, meat and frozen fish and other processed foods, produce negative returns; frozen fish uses 20 times more energy than it produces [Ponting p. 292]. If oil prices should rise consumers of these products will be in for a substantial sticker shock. Of course, none of this is to mention the external costs associated with burning and other uses of fossil fuels; acid rain, global warming, air pollution, ozone destruction, toxic wastes, and water pollution. It is to this subject we move next.

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