

The Industrial Revolution

by
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Introduction

The era known as the Industrial Revolution was a period in which fundamental changes occurred in agriculture, textile and metal manufacture, transportation, economic policies and the social structure in England. This period is appropriately labeled “revolution,” for it thoroughly destroyed the old manner of doing things; yet the term is simultaneously inappropriate, for it connotes abrupt change. The changes that occurred during this period (1760-1850), in fact, occurred gradually. The year 1760 is generally accepted as the “eve” of the Industrial Revolution. In reality, this eve began more than two centuries before this date. The late 18th century and the early 19th century brought to fruition the ideas and discoveries of those who had long passed on, such as, Galileo, Bacon, Descartes and others.

Advances in agricultural techniques and practices resulted in an increased supply of food and raw materials, changes in industrial organization and new technology resulted in increased production, efficiency and profits, and the increase in commerce, foreign and domestic, were all conditions which promoted the advent of the Industrial Revolution. Many of these conditions were so closely interrelated that increased activity in one spurred an increase in activity in another. Further, this interdependence of conditions creates a problem when one attempts to delineate them for the purpose of analysis in the classroom. Therefore, it is imperative that the reader be acutely aware of this when reading the following material.

Agricultural Changes

Agriculture occupied a prominent position in the English way of life of this period. Not only was its importance rooted in the subsistence of the population, but agriculture was an indispensable source of raw materials for the textile industry. Wool and cotton production for the manufacture of cloth increased in each successive year, as did the yield of food crops.

The improved yield of the agricultural sector can be attributed to the enclosure movement and to improved techniques and practices developed during this period. A common practice in early agriculture was to allow the land to lie fallow after it had been exhausted through cultivation. Later it was discovered that the cultivation of clover and other legumes would help to restore the fertility of the soil. The improved yields also increased the amount of food available to sustain livestock through the winter. This increased the size of herds for meat on the table and allowed farmers to begin with larger herds in the spring than they had previously.

Other advances in agriculture included the use of sturdier farm implements fashioned from metal. Up until this period most farming implements were made entirely out of wood. We do not find much technical innovation beyond the slight improvements made on existing implements. We do find increased energy being placed into the breeding of livestock, control of insects, improved irrigation and farming methods, developing new crops and the use of horsepower in the fields to replace oxen as a source of power.

These changes which have occurred in agriculture made it possible to feed all of the people that were attracted to the industrial centers as factory workers. By providing enough food to sustain an adequate work force, England was preparing the way for expansion of the economy and industry.

A strategy which may be employed to promote the students' understanding of the changes that have occurred in agriculture during the period of this unit, and from this period to today's modern farms, is to start with the present and work back in time to the period we are studying. Students may participate in an informative and interesting discussion centered around today's farming methods and machinery. Classroom activities could also center about constructing a chart which lists farming methods in pre-industrial revolution times, during the industrial revolution and today. Also, activities could be centered around having students write letters to manufacturers of farm machinery, the U.S. Department of Agriculture, or other farm-related concerns (e.g., farm museums).

In 18th century England, the enclosure of common village fields into individual landholdings, or the division of unproductive land into private property was the first significant change to occur. This concentrated the ownership of the land into the hands of a few, and made it possible to institute improved farming techniques on a wider scale. Students may engage in a debate over the question of enclosure, concerning its effect on the rural poor. Historians are not in complete agreement on the effects of enclosure on the poor, some arguing that it contributed to swelling the numbers of poor, while others argue that their plight was only marginally related to the enclosure movement. An excellent resource for the teacher's use in this section is Chapter Seven of E. P. Thompson's book, *The Making of the English Working Class*.

Textiles

Prior to 1760 the manufacture of textiles occurred in the homes, by people who gave part of their time to it. It was a tedious process from raw material to finished product. In the case of woolen cloth, the wool had to be sorted, cleaned and dyed. Then the wool was carded and combed. Next, it was spun into thread which was woven into cloth. Subsequent processes were performed upon the cloth to change the texture or the color of the woolen cloth. Many of these stages of production were performed by women and children. The supply of raw material for the woolen industry was obtained domestically. In the cases of silk and cotton, the raw materials were obtained from foreign sources, such as, China, the West Indies, North American and Africa.

The organization of the textile industry was complicated and grossly inefficient before the age of mechanization. Differences existed from one locality to another; generally, a merchant employed

putters-out to distribute the raw materials to spinners and weavers who were scattered throughout the countryside.

Changes in the textile industry were already occurring in the early 1700s; however, these changes were not easily accepted as evidenced by the workers' riots which broke out in response to these new machines. John Kay's flying-shuttle, which enabled one weaver to do the work of two, and Lewis Paul's roller spinner, which was to make spinning more efficient (later to be perfected by Richard Arkwright), were the precursors of the inventive spirit and the application of new technology to the textile industry.

In the mid-1760s the textile industry began to experience rapid change. James Hargreaves' jenny, a device which enabled the operator to simultaneously spin dozens of threads, was readily adopted. By 1788 nearly 20,000 of them were being employed in England. Arkwright and others developed the water frame. This device performed similarly to Paul's roller spinner, though its use demanded greater power than could be applied by muscle.

Arkwright enlisted the financial support of Samuel Need and Jedidiah Strutt to set up a water-powered factory that utilized his invention. This factory, located in Cromford, employed more than 600 workers, many of whom were women and children. The adage "necessity is the mother of invention" is quite appropriate here, for this machine spun the cotton thread faster than human hands could supply the carded and combed raw material. This led to Arkwright's development of a machine which would perform that function.

The changes that took place in the textile industry must certainly center about the inventions and their inventors, though not necessarily be limited to them. These inventions that were perfected and employed led to tremendous change in the world of work. Gone were the days of the Domestic System, yielding to the new ways of the Factory System. These factories which were to spring up throughout the countryside were large, dusty, poorly illuminated and ventilated and dangerous. The employment of women and children was commonplace and desired, for they were paid lower wages than their male counterparts. Working conditions in these factories were not subject to much regulation.

A strategy similar to the one that was suggested in the previous section may easily be employed here also. Discussions may center around today's textile industry, before moving on to the methods of preindustrial and industrialized England. Today, blue jeans are often referred to as "America's national dress." Some interesting discussions may develop around the manufacture of blue jeans, from the cotton fields to the finished product.

By comparing and contrasting conditions of work today and in days gone by, the students should begin to grasp the magnitude of impact that technological change has had on societies. The modern-day factory bears very little resemblance to Arkwright's factory at Cromford. Students may be assigned to write letters to the U.S. Department of Labor and its related agencies to request materials on factories today. Letters may also be written to representatives of the textile industry, as well as to labor unions within the industry. Students may also gather information concerning governmental regulation related to work in the textile industry. An excellent resource

which should be used by the teacher is E. Royston Pike's, *Hard Times: Human Documents of the Industrial Revolution*.

Coal Mining

One finds the working conditions and practices of coal mining in the 18th and 19th centuries to be risky, at best, and suicidal at worst. This industry, even today, provokes thoughts of hazards at every turn. During the 18th and 19th centuries one even finds specific jobs in mining which required the employee to have a "death wish" of sorts. For example, a fireman employed in a colliery had the duty of ridding a mine tunnel of dangerous, flammable gases. His job entailed crawling through the tunnel holding a long stick. Attached to the end of the stick was a lighted candle which exploded any gases that might be accumulated ahead of him. All of the jobs that existed in coal mining were not as dangerous as the fireman's,; however, every one of them could be termed hazardous.

Different methods of mining coal were employed in various locales throughout England. All coal mining had one trait in common; the movement of coal was accomplished solely by muscle power—animal, man, woman and child, the latter being the most desirable for their size. The process of removing the coal was obviously as slow as it was dirty. Coal was moved along horizontal tunnels by the basketful and hauled up a vertical shaft to the surface. Later, the underground movement of coal was speeded up by the utilization of ponies and carts on rail. The production of coal increased steadily, from 2 1/2 million to more than 15 million tons by 1829.

Improvements in coal mining came in the form of improved tunnel ventilation, improved underground and surface transportation, the use of gunpowder to blast away at the coal seams, and improved tunnel illumination through the use of safety lamps.

Coal mining today continues to be a hazardous job, though modern machinery and safety equipment have made the industry more efficient and safe. Students should better understand the difficulties of mining coal in the 19th century by studying modern-day coal mining. Several modern-day issues related to the use of coal (strip-mining, air pollution, etc.) should make for some lively discussions in class. Discussions may also touch upon the question of health-related problems of this industry (black lung disease).

It was not uncommon in the 19th century for women to be employed in the mining of coal. Entire families could be found working side by side in the mines. Several sections of Pike's book, *Hard Times*, are an excellent teacher resource for material related to women and children working in England's coal mines. All of these short stories, as well as the illustrations, should be sufficient to help the students to understand the harsh conditions that were endured by these people.

Iron

Improvements in the iron industry came in the early 18th century. Abraham Darby successfully produced pig iron smelted with coke. This was a significant breakthrough, for prior to this discovery pig iron was smelted with the use of charcoal. Charcoal, derived from the charring of wood in a kiln, was an excellent source of energy to smelt the iron; however, its widespread use caused a serious depletion of England's forests. Darby's technique was gaining popularity within the industry, though problems still existed due to its use. Iron produced through this method was impure and brittle, making it unsuitable for the forgemaster to be able to fashion in into implements, so its use was limited to castings. Later, improvements would occur which produced high quality material and improved techniques in fashioning it.

Transportation

As an integral part of determining the cost and availability of manufactured products and as a means of improved communications, and as an industry unto itself, the improvement of transportation stimulated the course of the Industrial Revolution. Finished products, raw materials, food and people needed a reliable, quicker and less costly system of transportation. Canals and rivers had long been used as a means of internal transportation.

The mid-1700s began the first construction of canals between industrial districts. The construction of trunk lines opened the central industrial districts in the 1770s. The major thrust of financial backing came from the merchants and industrialists, who had a great stake in their construction. The problem of moving bulk goods overland was addressed, at least for the time being, by canals. However, their days were numbered, for the coming of the railroads was imminent.

The principles of rail transport were already in use in the late 1700s. Tramways, using cast iron rails, were being employed in a number of mines in England. By 1800 more than 200 miles of tramway served coal mines. It is not surprising, then, to find a number of engineers connected with coal mines searching for a way to apply the steam engine to railways.

A number of men were involved in experimentation concerning the development of railroads in England. Between 1804 and 1820 we find a few partially successful attempts at developing a practical means of rail transport: Richard Trevithick's "New Castle," a steam locomotive that proved to be too heavy for the rails, John Blenkinsop's locomotive, which employed a toothed, gear-like wheel, and William Hedley's "Puffing Billy," which was used for hauling coal wagons from the mines.

A pioneer in railroads that bears mentioning here is George Stephenson. Stephenson was invited by the Stockton and Darlington Railway to build the railroad between those two towns. The Stockton to Darlington line was the first public railroad to use locomotive traction and carry passengers, as well as freight. The equipment on this line proved to be too expensive to maintain. This was not the last to be heard from Stephenson.

In 1829 the Liverpool and Manchester Railway sponsored a competition to determine the best type of locomotive. This contest took place on the Rainhill level at Lancashire from October 6 to 14, 1829. Three steam locomotives participated in the Rainhill Trials; Timothy Hackworth's "Sans Pareil," John Braithwaite and John Ericsson's "Novelty," and Stephenson's "Rocket." The "Rocket" won the Rainhill Trials. It is interesting and ironic to note here that the first railroad accident death occurred at these trials.

Railroads dominated the transportation scene in England for nearly a century. Railroads proliferated in England, from 1,000 miles in 1836 to more than 7,000 miles built by 1852. Here again is another example of economic necessity producing innovation. The development of reliable, efficient rail service was crucial to the growth of specific industries and the overall economy.

By researching the railroad industry in the United States, students will find them to have been neglected over the years. Railroads have been superceded by modern forms of transport and superhighways. Perhaps a renaissance is due for the railroads in this country. Students will also find that the railroads are a reliable means of transportation for passengers and freight in Europe. Some interesting discussions may evolve around the railroads' role in mass transit in an energy-conscious world.

Steam

The development and subsequent application of steam power was undoubtedly the greatest technical achievement of the Industrial Revolution. A number of industries needed the ability to apply the enormous power produced by the steam engine, in order to continue their advancement in production. James Watt is credited with the invention of the steam engine. In fact, Watt improved upon a design which was developed by Thomas Savery and Thomas Newcomen. Watt's engine improved the efficiency of Newcomen's engine fourfold, and he utilized the latest technology in gunmaking, where precision was absolutely necessary. The transfer of one technology to another is evident here, in that Watt used John Wilkinson's device for boring cannon to accurately bore the large cylinder for his engine.

The development of a practical, efficient steam engine and its application to industry and transportation caused a great leap for industrialization. Its application was virtually limitless, and it was responsible for lifting industries from infancy to adolescence. Obviously, the study of steam power can be a course of study unto itself, and it is included in various sections within this unit. H. W. Dickinson and H. P. Vowles book, *James Watt and the Industrial Revolution*, is an excellent teacher resource for use in the classroom. This book contains a number of drawings of early designs of steam engines, as well as a complete history of the search for the practical design.

The Human Aspect

In the 18th century the population grew at a faster rate than ever before. There are four primary reasons which may be cited for this growth: a decline in the death rate, an increase in the birth rate, the virtual elimination of the dreaded plagues and an increase in the availability of food.

The latter is probably the most significant of these reasons, for English people were consuming a much healthier diet.

One can find a myriad of reasons for the growth of the population, in addition to those above. Industry provided higher wages to individuals than was being offered in the villages. This allowed young people to marry earlier in life, and to produce children earlier. The old system of apprenticeship did not allow an apprentice to marry. City life provided young people with a greater choice of prospective partners, in contrast to the limited choices in some isolated village. Finally, industry provided people with improved clothing and housing, though it took a long time for housing conditions to improve.

With the adoption of the factory system, we find a shift in population. Settlements grew around the factories. In some cases, housing was provided to workers by their employers, thus giving the factory owners greater control over the lives of his workers. In some cases factories started in existing towns, which was desirable because a labor pool was readily available. The prime consideration for locating a factory was the availability of power. The early form of power was derived directly from moving water. Thus, we find factories cropping up in the hills near streams and rivers. Later, when steam power was developed, factories could be located near any source of water. Other factories, such as those involved in the manufacture of iron, had considerations of a different kind involving their location. Due to the great difficulty in moving bulk materials, such as iron ore, these mills had to be located close to the mineral source. In such situations, large communities grew directly above the seams of ore in the earth.

The development of the steam engine to drive machinery freed the mill owners from being locked into a site that was close to swiftly moving water. The steam powered mill still had to be located near a source of water, though the field of choice was much wider. Also, factories could be located closer to existing population centers or seaports, fulfilling the need for labor and transportation of materials.

The towns that grew in the North were crowded, dirty and unregulated. They grew so rapidly that no one took the time to consider the consequence of such conditions. In the areas of public sanitation and public health, ignorance reigned. No one understood the effects of these unsanitary conditions upon humans. Conditions in these densely populated areas worsened to the point of the reappearance of outbreaks of disease. In the mid-1800s there were several outbreaks of typhoid and cholera. Some attention to these conditions was accorded by Parliament in the form of Public Health Acts. These acts did improve conditions, though they were largely ineffective, for they did not grant local Boards of Health the powers to compel improvements.

E. Royston Pike's *Hard Times* is literally a treasure chest brimming with short stories that document living and working conditions during the Industrial Revolution. These stories may be utilized in the classroom in a variety of ways, and they should be quite effective in conveying the reality of life during this period. Pages 43-57 of Pike's book provide an excellent overview of typical living conditions.

Capital

Prior to industrialization in England, land was the primary source of wealth. The landed aristocracy held enormous powers the feudal system. However, a new source of great wealth grew from the Industrial Revolution, that which was derived from the ownership of factories and machinery. Those who invested in factories and machinery cannot be identified as belonging to any single class of people (landed aristocracy, industrialists, merchants). Their backgrounds were quite diverse, yet they had one thing in common: the daring to seize the opportunity to invest in new ventures. It was these capitalists who gave the necessary impetus to the speedy growth of the Industrial Revolution.

In the early years of this period we find most investments being made in a field closely related to one's original source of capital. Manufacturers took a substantial portion of their profits to "plough back" into their business, or they invested capital in ventures that were related to their primary business. Eventually, as opportunities to realize great profits proliferated, it was not uncommon to find these entrepreneurs investing substantially in concerns about which they knew very little.

Two kinds of capital were needed by these industrialists; long-term capital to expand present operations, and short-term capital to purchase raw materials, maintain inventories and to pay wages to their employees. The long-term capital needs were met by mortgaging factory buildings and machinery. It was the need for short-term capital which presented some problems. The need for short-term capital for raw materials and maintaining stock was accommodated by extending credit to the manufacturers by the producers or dealers. Often, a supplier of raw materials waited from 6 to 12 months for payment of his goods, after the manufacturer was paid for the finished product.

The payment of wages was not an easily solved problem, one which taxed the creativity of employers. The problem was in finding a sufficient amount of small value legal tender to pay the wages. Some employers staggered the days on which they paid their employees, while others paid them in script. Some paid a portion of their work force early in the day, allowing them to shop for household needs. When the money had circulated through the shopkeepers back to the employer, another portion of the work force was paid. All of these methods proved to be unacceptable.

The root of the problem was the lack of an adequate banking system in these remote industrial centers. The Bank of England, established in the late 1690s, did not accommodate the needs of the manufacturers. It concentrated its interest on the financial affairs of state and those of the trading companies and merchants of London.

The early 1700s brought with it the first country banks. These private banks were founded by those who were involved in a variety of endeavors (goldsmith, merchant, manufacturer). Many industrialists favored establishing their own banks as an outlet for the capital accumulated by their business and as a means for obtaining cash for wages. When the Bank of England tightened credit because of government demands, many of these banks failed. A great number of them had a large proportion of their assets tied up in long-term mortgages, thus leaving them vulnerable when demands for cash were presented by their depositors. From 1772 to 1825, a large number of these banks failed. Their limited resources were inadequate to meet the demands of the factory

economy. A banking system was eventually set up to distribute capital to areas where it was needed, drawing it from areas where there was a surplus.

Labor

If the conditions in which people lived in these factory towns were considered bad, then the conditions in which they worked can be appropriately characterized as being horrendous. Inside these factories one would find poorly ventilated, noisy, dirty, damp and poorly lighted working areas. These factories were unhealthy and dangerous places in which to work. Normally, workers put in twelve to fourteen hours daily. Factory Acts that were later enacted by Parliament regulated the number of hours that men, women and children worked. Pages 58-74 of E. R. Pike's book, *Hard Times*, make for interesting reading on this subject.

The factory system changed the manner in which work was performed. Unlike the domestic system the work was away from home, in large, impersonal settings. Workers were viewed by their employers merely as "hands."

Slowly, workers began to realize the strength they could possess if they were a unified force. It was a long, uphill battle for workers to be able to have the right to organize into officially recognized unions. Their lot was one of having no political influence in a land where the government followed a laissez-faire policy.

This hands off policy changed as the pressure from growing trade unions increased. A movement was beginning to free workers from the injustices of the factory system. Political leaders called for reform legislation which would address these injustices (see lesson plans for specific legislation).

