***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.

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.

***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. 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.

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.

***Coal Mining***

One finds the working conditions and practices of coal mining in the l8th and l9th centuries to be risky, at best, and suicidal at worst. This industry, even today, provokes thoughts of hazards at every turn. During the l8th 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.

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.

***Iron***

Improvements in the iron industry came in the early l8th 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 source 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 Cast1e,” 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.

***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.