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3. The Second Industrial Revolution

Robert L. Bloom
Gettysburg College

Basil L. Crapster
Gettysburg College

Harold L. Dunkelberger
Gettysburg College

See next page for additional authors

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3. The Second Industrial Revolution

Abstract

There is abundant evidence for the opinion that after about 1850 the Industrial Revolution entered upon a new phase in its development. Inventions occurred at a more rapid pace than ever before in history. (Between 1850 and 1914 there were more than fifty times as many patents issued in the United States as during the preceding sixty years.) Increasingly these inventions were the work of scientists and engineers working in the research laboratory rather than of self-taught craftsmen, as had often been the case in the eighteenth century. *[excerpt]*

Keywords

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Disciplines

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Comments

This is a part of [Section XIV: The Industrial Revolution, Classical Economics, and Economic Liberalism](#). The [Contemporary Civilization](#) page lists all additional sections of *Ideas and Institutions of Western Man*, as well as the [Table of Contents](#) for both volumes.

More About Contemporary Civilization:

From 1947 through 1969, all first-year Gettysburg College students took a two-semester course called Contemporary Civilization. The course was developed at President Henry W.A. Hanson's request with the goal of "introducing the student to the backgrounds of contemporary social problems through the major concepts, ideals, hopes and motivations of western culture since the Middle Ages."

Gettysburg College professors from the history, philosophy, and religion departments developed a textbook for the course. The first edition, published in 1955, was called *An Introduction to Contemporary Civilization and Its Problems*. A second edition, retitled *Ideas and Institutions of Western Man*, was published in 1958 and 1960. It is this second edition that we include here. The copy we digitized is from the Gary T. Hawbaker '66 Collection and the marginalia are his.

Authors

Robert L. Bloom, Basil L. Crapster, Harold L. Dunkelberger, Charles H. Glatfelter, Richard T. Mara, Norman E. Richardson, and W. Richard Schubart

3. The Second Industrial Revolution

There is abundant evidence for the opinion that after about 1850 the Industrial Revolution entered upon a new phase in its development. Inventions occurred at a more rapid pace than ever before in history. (Between 1850 and 1914 there were more than fifty times as many patents issued in the United States as during the preceding sixty years.) Increasingly these inventions were the work of scientists and engineers working in the research laboratory rather than of self-taught craftsmen, as had often been the case in the eighteenth century. Machines were perfected which could bore, plane, or grind metal with great precision. Machine tools such as the lathe, boring mill, and milling machine began turning out parts which were readily interchangeable with each other and could be assembled quickly without further shaping. Industrialists became aware of the tremendous possibilities for the mass production of goods that were inherent in the principle of the interchangeability of parts. The machines of mass production

were more precise, specialized, complicated, automatic, rapid, and expensive than earlier machines had been; and they were extended to more of the changing processes of production. Factories grew larger and larger, on the supposition -- often a correct one -- that this led to higher profits. Year after year existing production records were surpassed. Few old industries escaped significant alteration, new industries came into existence, and new sources of power as well as new methods of producing and distributing goods were sought and found. And by 1850 the Industrial Revolution was beginning to influence other countries as it had already influenced England.

These and other amplifications of earlier developments constitute what is frequently called the Second Industrial Revolution. It was accompanied by the continued increase in world population. Since it enlarged the need of the Western economies for raw materials and markets, it helped bring about the revival of imperialism after 1870. Since it multiplied the power resources available to the people it touched, the Second Industrial Revolution gave a new and potentially terrifying meaning to nationalism and to war. Moreover, the continuing growth of cities accentuated the serious social problems created in the earlier period by the rather sudden break-up of the agricultural patterns of Western men and by their rude transformation into urban creatures. Finally, the Second Industrial Revolution coincided in point of time with the pinnacle of power and influence reached by Europe, the birthplace of Western Civilization. Since 1914, however, with the effects of two world wars and the competition of other areas, that power and influence have been on the decline.

The period after 1860 is sometimes called the Age of Steel. It is impossible to imagine an effective substitute for steel in the production of modern buildings, machines, bridges, rails, and myriads of smaller items. As we have noted, the industrial developments of the eighteenth century included innovations in the iron industry, but had failed to yield a method for making low-cost steel in large quantities. Then, about 1860, two processes made this possible for the first time. One, known as the Bessemer process (1856), was devised by an Englishman and an American working independently of each other. The other, the open-hearth process (1868), because of the greater control which it gave over the quality of the steel, in time overshadowed the Bessemer method. With these two inventions, and a process devised in the 1870's for using high phosphorous iron ore, the price of steel fell by more than half within a brief period. The quantity produced increased rapidly. Between 1850 and 1914 world steel production multiplied more than one hundred fold.

A thriving economic life demands adequate transportation and communication facilities. The nineteenth century witnessed a more revolutionary change in such facilities than any other previous century in human history. In Great Britain John Macadam (1756-1836) and others pioneered in the first significant

innovations in road building since the Romans. Macadamizing came to mean paving the prepared bed of a road with finely crushed rock, bound together with bitumen. Numerous private companies were chartered to build toll roads, known as turn-pikes. In Great Britain and elsewhere many canals were constructed in the late eighteenth and early nineteenth centuries, through which coal, ore, timber, and other products were successfully transported at greatly reduced cost. There was also a phenomenal increase in the merchant marine tonnage of the Western World, in which Great Britain took the lead. Improvements in the steam engine, the introduction of the screw propeller, and low-cost steel helped Britain outmode the famous American clipper ship -- the fastest thing that ever sailed -- with the oceangoing steamship, although this triumph did not take place before the 1870's, long after Robert Fulton's invention. The expansion of Europe took on a new meaning as, within a lifetime, the world's commerce increased perhaps as much as tenfold.

More efficient at the time in traversing land than either the highway or the canal, the railroad provided another great change in the transportation picture after 1850. In that year Great Britain already had about 6000 miles of track, all but a trifle of which had been built since 1830. The railroad came to Britain when her industrialization was already far advanced. It was never as crucial for her as it was for such countries as the United States, where tremendous distances had to be covered and where by 1850 almost 9000 miles of track were already in use. During the sixty years that followed, a significant proportion of the industrial energies of the Western World were devoted to building railroad networks, long to be one of the dependable heralds of approaching industrialization. By 1910 the United States, for example, had about twenty-eight times the mileage of 1850. Because of the great expense involved in this construction and in subsequent maintenance of the lines, the aid of government was often obtained. Outside the United States, most of the railway systems eventually fell under government ownership.

Near the end of the nineteenth century, a new source of power in the form of the internal combustion engine began to challenge the supremacy of steam and effect another great change in transportation. Developed in the 1880's and making use of one of several possible fuels, by 1914 this innovation in the form of the diesel was being applied on a limited scale to the ocean vessel and the locomotive. The gasoline engine was employed in the motor vehicle, which by 1914 was becoming a major transportation facility. Although pioneered in Europe, the automobile was to be associated particularly with the United States, where about 1,750,000 motor vehicles were registered in 1914. In that year Henry Ford (1863-1947) introduced the mass-production methods which more than anything else brought the automobile within the reach of most American families. One final application of the internal combustion engine must be

noted at this point. The airplane had been proved practicable by 1914. It received its first big boost in the world war which began in that year.

Important developments in the field of communication included the telegraph (placed in operation in 1844 and quickly adopted in England and America), the submarine cable (connecting England and France after 1851 and crossing the Atlantic after 1866), and the telephone (patented in 1876). By 1914 the basic research which made possible the radio had been completed, and Guglielmo Marconi (1874-1937) had already sent messages across the Atlantic Ocean.

Although the steam engine was made much more efficient during the course of the nineteenth century, there still remained the objection that it required a considerable amount of bulky fuel. A half century or more of research resulted in the development of the generator, which ushered in another new age: the Age of Electricity. The first electric power plant in the world was erected in Manhattan in 1882 by Thomas A. Edison (1847-1931). Electricity could be generated by the power of water, coal, or petroleum, and then be transmitted if desired as much as several hundred miles. It was adaptable to the factory, farm, and home, and gave rise to many new industries.

From the very beginning, one of the outstanding features of the Industrial Revolution was the fact that large sums of capital were required to initiate and carry forward business undertakings. This was more obvious in the nineteenth century than ever before. As the production processes became more elaborate and complicated the optimum size of the business establishment, or plant, increased. As a result, still more capital was required.

This particular fact was dramatized by the advent of the railroad in England. It had been possible for an entrepreneur and a small group of his friends to finance a cotton mill, and then plough the profits back into the business to keep it up to date. But how could one ever hope to finance railroads under such conditions? Before 1850 England had moved to encourage their private construction by permitting railroad companies to issue stock which carried with it only limited liability. Between 1855 and 1862 this privilege was extended to all other stockholders. Limited liability meant that a stockholder could lose only his original investment in the event the business failed; he would not be further liable for its debts. This principle gave rise to the modern industrial corporation in England and other countries as well.

The advantages of the corporate form of business organization over the individual proprietorship and the partnership were many. Ownership could be transferred readily, simply through the buying and selling of stock certificates. Since the charter was granted for a long, often an indefinite, period

of time, the corporation had a permanence that the other forms of organization lacked. The corporation was a person in the eyes of the law, with the privileges and immunities associated with such a status. The principle of limited liability itself encouraged potential investors. Also, the corporation could tap many reservoirs of capital, both large and small.

From the point of view of society, the modern corporation was not without its potentially serious disadvantages. Most of these centered around the fact that this type of organization made it possible to separate ownership, by the stockholders, from control, by the management. It is true that the managers usually held stock and were, therefore, owners; but they were not the only owners and usually they had only a small proportion of the shares outstanding. It was relatively easy for dishonest managers, who were in possession of the minutest details of the business and who controlled its funds, to operate the corporation for their own benefit, to the exclusion of the interest of the owners, the workers, and the public.

The rise of the modern industrial corporation was soon followed by what historians often call finance capitalism. As we have seen, the corporation was a device which could command large amounts of capital. A special class of middlemen developed, the investment bankers, whose function was originally merely to facilitate the buying and selling of corporate securities. They did this through their own facilities and through the medium of the stock exchange, by which means they disposed of new issues of securities offered when a corporation was about to begin operations or when it needed new capital. In addition, these bankers had access to large funds of their own which they could make available to corporations. In time, the functions of investment bankers increased. To protect their investments, they often exercised considerable control over the corporations in which they were financially interested. Often, they were responsible for initiating new business firms. These latter two types of activities are what is meant by the term "finance capitalism." The investment banker was never as important in England as he was in newer industrial countries.

Accompanying the rise of the investment banker during the Second Industrial Revolution was another phenomenon: the tendency toward consolidation of business firms. As we have already seen, there were forces at work increasing the optimum size of the business establishment, or plant. The reference here is to the consolidation of firms, or companies, into larger and larger units. This tendency has been explained in several ways. Larger firms often purchased raw materials cheaper than small ones. They could install the latest equipment, hire the most efficient labor, conduct research, use by-products, and perhaps reduce selling costs. Businessmen hoped that larger firms could weaken and perhaps eliminate their competition, thus further increasing profits. Another factor in explaining combinations was the desire to bring order to what may have been a chaotic, competitive industry.

Consolidation of firms - through a merger, or a cartel (agreement between firms on prices, through lip service, or a trust - stockholders turn their voting rights of their stocks over to trustees holding co.-owns stock in another companies and controls them. Men who control capital has more control than manager

The consolidation of business firms became pronounced after 1870, when in one country after another production, momentarily at least, caught up with demand. The reaction of governments to this development varied. In Germany, for instance, firms in many industries turned from competing with each other and entered into agreements by the terms of which they regulated prices, divided markets, or pooled profits, and occasionally engaged in all of these practices. The characteristic form which these agreements took has been called the cartel. The German government approved this movement, and there were about 400 such agreements in force in 1914. In England, the usual form of consolidation was the merger, or amalgamation. Here, too, there was little government opposition. It was in the United States that the most substantial governmental efforts were made, within the spirit of capitalism, to control the particular forms which big business took there: the trust and the holding company.