Another revolution was in the financing of railroads and other new industrial corporations. Building railroads was expensive—more so than almost any other business. Railroad executives soon came to rely on investment bankers to assist in raising capital. By the late 1880s, John Pierpont Morgan had emerged as the nation’s leading investment banker. Son of a successful banker, young Morgan was educated in Europe, began working in his father’s bank in London, then moved to a bank in New York. Railroads had a voracious appetite for funds, but Morgan’s investors wanted to put their money where it would be safe and provide a reliable return. Morgan therefore tried to stabilize the railroad business. When companies came to Morgan for funds, he often insisted on reorganization to simplify corporate structures and combine separate lines into larger, centrally controlled systems. He also often insisted that a representative of the House of Morgan be added to the company’s board of directors, so that the company would continue to follow policies that would provide a safe and reliable return on Morgan’s investment. Some began to call this process “Morganization,” and “Morganized” lines included some of the largest in the country. A few other investment bankers followed similar patterns. By the early 1900s, such reorganization had created twelve large railroad systems that controlled more than half of all the country’s railroad mileage, and twenty others that operated most of the rest. The largest systems were interlocked with each other into a half dozen massive networks, each affiliated with a leading New York banking house. By then, Morgan had already turned his attention to other industries, especially steel.

A second revolution was in the size and structure of manufacturing. The career of Andrew Carnegie in the steel industry provides an example. He was born in Scotland in 1835, and his penniless parents brought him to the United States in 1848. After a short time working in a textile mill, he became a messenger in a telegraph office, then a telegraph operator, then the personal telegrapher for a high official of the Pennsylvania Railroad, one of the largest in the country. At the age of 25, he moved into a high management position with the railroad. After five years there, he went into the iron and steel industry, where he applied the management lessons he had learned with the railroad.

Carnegie’s motto was “Cut the prices; scoop the market; run the mills full”—that is, set prices low enough to undercut his competitors and always run his plants at full capacity so that his capital investment produced the highest possible return. He took every opportunity to cut costs so that he might show a profit while charging less than his rivals. In 1864, steel rails sold for $126 per ton; by 1875, Carnegie was selling them for $69 per ton. Driven by improved technology and Carnegie’s competitiveness, steel prices continued to fall, reaching less than $20 in the late 1890s. By then, the nation led the world in steel production.

Carnegie’s steel plants stood at one end of a long chain of operations that he owned outright or controlled through partnerships: iron ore mines, ships that transported iron ore across the Great Lakes, railway lines, coal lands, ovens to produce coke (coal treated to burn at high temperatures), and plants for turning iron ore into iron and steel. Bringing together all these operations under one company is called vertical integration—and it was something new to American manufacturing. Control over the sources and transportation of raw materials guaranteed a reliable flow of crucial supplies at predictable prices—and may also have denied raw materials to competitors. Carnegie and other leading entrepreneurs saw technology as another competitive device, permitting the production of better quality goods at lower prices. In 1901, Carnegie sold his company to J.P. Morgan who then combined Carnegie’s operations with other steel companies he had invested in, creating United States Steel, the country’s first corporation capitalized at more than a billion dollars.

Carnegie’s company was larger and more complex than any manufacturing enterprise in pre–Civil War America but was by no means unique in the late nineteenth century. Other companies also operated large and complex plants—by 1900, three steel plants each employed between 8,000 and 10,000 workers, and seventy other factories employed more than 2,000 workers, producing everything from locomotives to processed meat. Some companies operated more than one giant factory. Carnegie Steel ran two of the seventy largest factories, as did General Electric and Western Electric.
ROCKEFELLER
Where Carnegie Steel sold his steel mostly to other large companies, Standard Oil sold mostly to final consumers. Standard Oil, run by John D. Rockefeller and his partners, revolutionized the petroleum industry. At the time, the major product of oil refining was kerosene, used primarily for home lighting. Rockefeller, in 1863, invested in a refinery in Cleveland, Ohio, then the center of petroleum refining—a business relatively easy to enter but highly competitive. Like Carnegie, Rockefeller was an aggressive competitor. He usually sought to persuade his competitors to join the cartel he was creating. Failing that, he would try to drive them out of business.

By 1881, Rockefeller and his associates controlled some forty oil refineries, accounting for about 90 percent of the nation’s refining capacity, giving them a monopoly (monopoly means “one seller”) over refining. Monopolizing one step in the manufacturing process is also called horizontal integration. In the 1880s, Standard moved to vertical integration by gaining control of oil fields, building its own transportation facilities (including pipelines and oceangoing tanker ships), and creating its own marketing operations. By the early 1890s, Standard Oil had achieved virtually complete vertical and horizontal integration of the American petroleum industry—something unusual in American business. Standard’s monopoly proved to be short-lived, however. With the discovery of new oil fields in Texas and elsewhere, new companies tapped those fields and quickly followed the path of vertical integration.

By the early 1880s, Rockefeller and his partners controlled companies in several states, but state laws required companies to operate only in the state in which they were chartered. To centralize decision-making in all their holdings, they created the Standard Oil trust, a new organizational form. Rockefeller and his partners who held shares in the individual companies exchanged their stock for trust certificates issued by Standard Oil. Standard Oil thus controlled all the individual companies, though technically it did not own them. Having centralized decision-making, Standard Oil consolidated its operations by closing more than half of its refineries and building several larger plants that incorporated the newest technology. One outcome was greater efficiency—the cost of producing petroleum products fell significantly, as did prices paid by consumers. Soon, new laws in New Jersey permitted corporations chartered there to own stock in other companies. So Rockefeller set up Standard Oil of New Jersey as a holding company for all the companies in the trust. Though the trust was only a temporary expedient for Rockefeller, the term trust quickly became synonymous with monopoly and then was applied to any large industrial enterprise.

Rockefeller retired from active participation in business in the mid-1890s. By then, Standard Oil no longer had a monopoly, but the “Rockefeller interests” (companies dominated by the Rockefeller family) had become highly diverse and even more powerful. They included the National City Bank of New York (an investment bank second only to the House of Morgan), railroads, mining, real estate, steel plants, steamship lines, and other industries.

FORD (PBS – A Science Odyssey)
In 1899 Henry Ford left Edison Machines to help run the Detroit Automobile Company. Cars were still built essentially one at a time. Ford hoped to incorporate ideas from other industries -- standardized parts as Eli Whitney had used with gun manufacturing, or assembly line methods George Eastman tried in photo processing -- to make the process more efficient. This idea struck others in his field as nutty, so before long, Ford quit Detroit Automobile Company and began to build his own racing cars. They were good enough to attract backers and even partners, and in 1903, he set up the Ford Motor Company.

Ford's engineers took the first step towards this goal by designing the Model T, a simple, sturdy car, offering no factory options -- not even a choice of color. The Model T, first produced in 1908, kept the same design until the last one -- number 15,000,000 -- rolled off the line in 1927. From the start, the Model T was less expensive than most other cars, but it was still not attainable for the "multitude." Ford realized he’d need a more efficient way to produce the car in order to lower the price. He and his team looked at other industries and found four principles that would further their goal: interchangeable parts, continuous flow, division of labor, and reducing wasted effort.

Using interchangeable parts meant making the individual pieces of the car the same every time. That way any valve would fit any engine, any steering wheel would fit any chassis. This meant improving the machinery and
cutting tools used to make the parts. But once the machines were adjusted, a low-skilled laborer could operate them, replacing the skilled craftsperson who formerly made the parts by hand. To improve the flow of the work, it needed to be arranged so that as one task was finished, another began, with minimum time spent in set-up. Ford was inspired by the meat-packing houses of Chicago and a grain mill conveyor belt he had seen. If he brought the work to the workers, they spent less time moving about. Then he divided the labor by breaking the assembly of the Model T into 84 distinct steps. Each worker was trained to do just one of these steps. Ford called in Frederick Taylor, the creator of "scientific management," to do time and motion studies to determine the exact speed at which the work should proceed and the exact motions workers should use to accomplish their tasks.

Ford put these principles into play gradually over five years, fine-tuning and testing as he went along. In 1913, they came together in the first moving assembly line ever used for large-scale manufacturing. Ford produced cars at a record-breaking rate. That meant he could lower the price and still make a good profit by selling more cars. Ford had another notion, rather original in its time: the workers were also potential consumers! In 1914, Ford workers' wages were raised to $5 a day -- an excellent wage -- and they soon proved him right by buying their own Model Ts. Ford was called "a traitor to his class" by other industrialists and professionals, but he held firm in believing that well-paid workers would put up with dull work, be loyal, and buy his cars.

Ford's manufacturing principles were adopted by countless other industries. Henry Ford went beyond his 1907 goal of making cars affordable for all; he changed the habits of a nation, and shaped its very character.