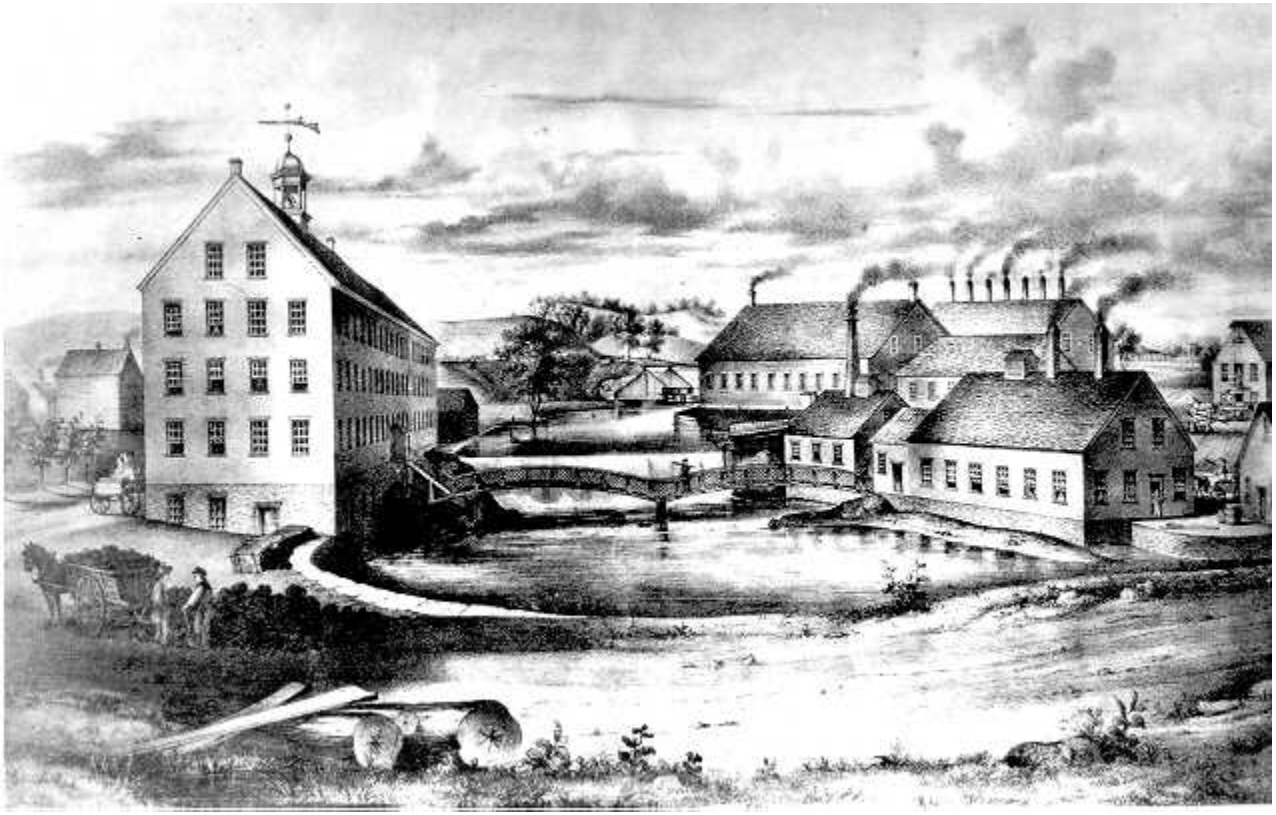
Industrial Revolution in the Upper Connecticut River Valley: An Overview



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American Precision Museum
Windsor, Vermont 2007

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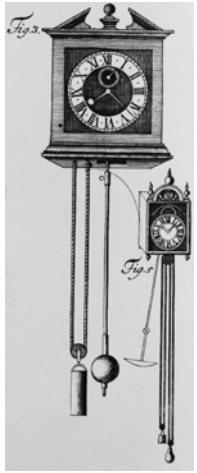


In the year 1800, among white adults in America, only one in fifty owned a clock, and one in thirty-two had a watch.[1] How many clocks are there in your home? What happened?

Perhaps most people in America didn't feel the need for a clock in 1800. Farm families worked by the rhythm of the sun and the seasons. The gristmill operator was often also a farmer, and he could work in his own fields until a neighboring farmer arrived with a load of grain to be turned into flour. Some women took in sewing at home, and their paid work was interspersed with household chores and with caring for children. The local school bell and the church bell called people together when it was time for them to gather. But even if they had wanted clocks, most people could not have had them. Clocks were made by hand, one at a time, by skilled craftsmen, and only the wealthy could afford them. Then, by 1850, American clockmakers had begun to produce a $2.00 clock—a clock that could be purchased by an ordinary worker and placed on a shelf in the ordinary home.

What happened was this: a strong and steady process of invention and innovation brought about a change so dramatic that it has long been called the Industrial Revolution. Those changes were not developed by a few isolated geniuses somewhere far away. Many of them developed in the small towns and villages of New England. By studying the history of our own towns, we can discover how industrialization happened and how it affected our communities and the world at large.

Why Here?

The same philosophies that inspired the Enlightenment and the American Revolution inspired changes in technology. People in Western Europe and America had come to believe that humans could improve their lives through work, that science could provide control over nature, and that the role of government was to serve the welfare of the people rather than the welfare of the king. Laws were developed that encouraged inventors to invent. Economic and legal systems encouraged people to engage in business. The social setting also encouraged invention. The Puritans had valued education, and they created the expectation that there would be schools in every community. Life on the frontier demanded self-reliance and creative problem solving. And so the population that grew in New England was eager and able to solve problems through innovation.

At the same time, the natural environment of New England encouraged technical innovation. Thousands and thousands of acres of forest provided lumber for the ships and masts needed by England's expanding, seagoing empire. Rivers running

down the hillsides provided water to power mills. Long before the American Revolution, water-powered sawmills were scattered across the northern states. In the 1760s in Windsor, Vermont, two dams were built on Mill Brook, and the reserved waterpower ran a sawmill at the upper dam and a gristmill at the lower one.[2] Clustering around the mills in towns across northern New England, communities began to grow. Within those new communities, more crafts and small industries were established: blacksmiths' shops, wheelwrights' shops, and carding mills for combing wool and making it ready to spin into yarn.

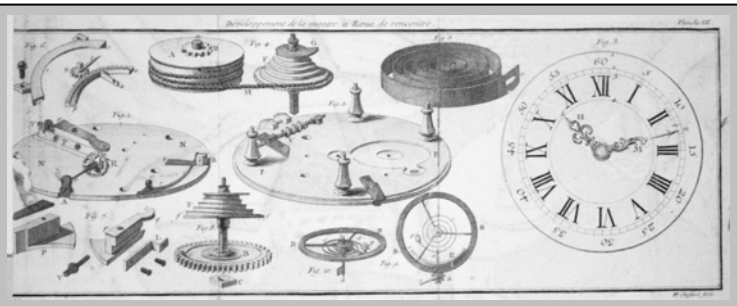
Beginnings of Industry

Spinning, sewing, and weaving were still mostly done at home, but gradually people began to specialize. Perhaps a farm wife wanted to make clothes for her family, using the wool from her own sheep. First, she would send the wool to a nearby water-powered carding mill to be prepared for spinning. She then might spin the wool into yarn herself. Next, she might take the yarn to a neighbor who had a large loom and who wove cloth for the whole community. The woven cloth then needed to be turned into a garment—perhaps a skirt or a coat. Gradually, small businesses—cottage industries—began to grow. When workers were brought together to share tasks and equipment, work became more efficient. Products could be made more quickly. Local merchants began to seek markets farther away, and New England shoes, salted codfish, furniture, and other goods were traded up and down the coast and throughout the West Indies.

The British government, however, put severe restrictions on American industries. In 1767, Benjamin Tyler journeyed on foot from Farmington, Connecticut to Claremont, New Hampshire, where he set up a sawmill and then a forge. There was bog ore in nearby Charlestown, and soon Tyler had installed all of the equipment needed to turn the ore into iron. Under British colonial law, this activity was forbidden and

punishable by a fine of 500 pounds, but Tyler persevered. Eventually he also owned a quarry that produced grinding stones for gristmills, and he invented a new type of water wheel.[3] Some historians have argued that the American Revolution was caused as much by the desire of entrepreneurial Americans to have their own industries as by the desire for political freedom. In 1776, the political revolution began, but the industrial revolution was also underway.

During the War of Independence, all British imports were cut off. The need for American-made products became even more acute, and industries continued to develop. After the war, it was still illegal in England to export new technology to America, and the Americans struggled to catch up with technological changes that were occurring in Europe. In 1790, defying the law, Samuel Slater slipped out of England and traveled to Rhode Island carrying—in his head—plans for a cotton-spinning machine. On the Blackstone River in Rhode Island, Slater created the first large textile mill in the United States. By 1809 there was a small textile mill in Manchester, New Hampshire. A few years later, on the Charles River just outside of Boston, Francis Lowell built the first mill in the world that took in raw cotton, carded it, spun it, and wove it into cloth. A cotton mill was built in Newport, New Hampshire in 1813, and in the 1830s the Monadnock Mill was established in nearby Claremont. Monadnock Mills would become one of the largest textile mills in the upper Connecticut Valley. As the textile industry began to grow, tools and machines to build the textile machines had to be developed, and so a machine industry also began to grow.



In 1802, in Connecticut, a man named Eli Terry built a clock factory that used waterpower to run machinery to make clock parts. The gears were cut from wood, and Terry's machines could cut parts with the same shape and dimensions, quickly and reliably. The clocks could be assembled easily, without much hand fitting of individual parts. Terry's wooden clock parts did not need to be highly accurate in order for the clock to work. When rolled, sheet brass became more available and more clocks were made of brass, the gears would be cut more accurately. In the gun industry, parts would need to be accurate to within a hundredth of an inch.[1]

The American System

The machine industry did not emerge only from the needs of the textile factories. Military needs also drove the development of new technology in the 1800s. Military leaders had long recognized that guns made by skilled gunsmiths could not supply a large army. Thousands of guns needed to be made at the same time. More important, guns that broke in the field needed to be fixed. A hand-crafted gun was a unique mechanism with all of its parts hand filed and fitted together. If

it broke, only a skilled gunsmith could repair it. If the guns could all be alike, with parts uniform to within certain tolerances, parts could be interchanged and guns could be repaired on the battlefield.

As early as the 1780s, the French had experimented with guns made from interchangeable parts. In the 1790s, the U.S. government armory in Springfield, Massachusetts, began to use labor-saving machinery, and a few private gun makers began to try to create weapons with interchangeable parts. In 1819, John Hall began installing machines for making gun parts at the government arsenal at Harper's Ferry, and he completed his first batch of interchangeable rifles in 1824. In the following years, Hall designed other special machines and gauges (measuring devices) for creating uniform gun parts. Between 1813 and 1830, Thomas Blanchard developed an automatic lathe that could produce wooden gunstocks. It was first used at the arsenal in Springfield.[4] These early machine developers were called mechanics or artisans, rather than inventors. They shared their work with each other as they moved from one factory to another, and from the government armories to the private arms companies and then back to the armories. Knowledge of the new gun making methods began to spread. By the 1840s, it had arrived in Windsor, Vermont.

Nicanor Kendall and Richard Lawrence met at the Vermont State Prison in Windsor. Neither was a convict. "Cain" Kendall had been trained as a blacksmith and wheelwright, but found that he preferred custom gun making. When he married the daughter of the prison warden, Kendall set up shop at the prison and put some of the inmates to work making gun parts.

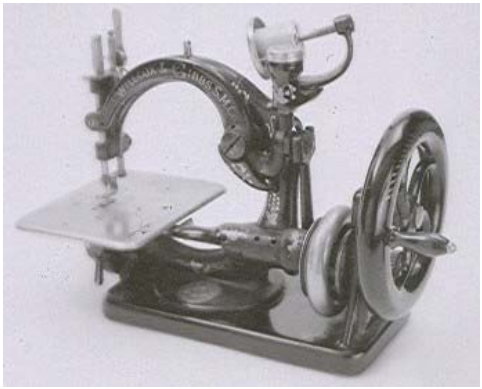
In 1838, a twenty-one-year-old named Richard Lawrence arrived in town on a stagecoach that had brought him across the Green Mountains from upstate New York. A young man at loose ends, he had recently spent three months in the army guarding the frontier during the Canadian Rebellions (also known as the Patriot War). He then had traveled and done odd jobs for several more months. When he stopped in Windsor to visit friends and relatives, he made known his skill and interest in gun making, and before long he had signed on to work for Kendall. By 1843, Kendall and Lawrence were partners with a shop of their own downstream on Mill Brook.[5]

They were still using a combination of machinery and hand-crafting to produce custom guns when Samuel E. Robbins came by one day in the winter of 1844 and made a bold proposal. Hostilities were building between the United States and Mexico, and the government was looking for a private contractor to supply 10,000 Harper's Ferry-type U. S. Army rifles. Robbins persuaded Kendall and Lawrence to form a new company and submit a bid. Their bid was lower than any other, and they won the contract.[6] New buildings sprang up in Windsor, both for factory space and for housing. Workers were recruited from the gun shops of Eli Whitney in Hartford, Connecticut; from the machine shops at textile mills in New Hampshire; and from the government armories. From the Silver & Gay company in North Chelmsford, Massachusetts, came Frederick W. Howe, who would turn out to be one of the most creative machine tool inventors of his time. Together, he and Richard Lawrence gathered, developed, and invented an array of tools that brought the Windsor armory to the forefront of both machining and arms making.

It was not *just* the use of new machines, however, that put Robbins, Kendall & Lawrence at the head of a revolution in manufacturing. The production of interchangeable parts depends upon the use of measuring tools and templates to ensure that each part is, within a certain tolerance, like every other corresponding part. The use of these tools; the powered machines; the automatic, repeatable metal cutting; and the division of labor in the factory produced a new system of manufacturing that came to be known as the American System. At first, guns produced with this system were just as expensive as handcrafted guns, but the government felt a great need to produce guns in quantity, with interchangeable parts. And the national treasury had the resources to make sure that the technology was developed.

Soon the results of this new system attracted attention in other parts of the world. In 1854, the British government sent a committee to study the machinery of the United States and to order not only guns but also machines to outfit a British armory. They ordered 25,000 rifles and 150 machines from Robbins & Lawrence. The little company in Windsor seemed headed for great success, but a series of business mis-adventures weakened them. Then a drought in Pennsylvania disrupted the supply of wood for gunstocks. Finally, the Crimean War ended abruptly, leaving the British with a less urgent need for rifles. By 1856, Robbins & Lawrence Company was dissolved in bankruptcy proceedings. Nevertheless, work continued in the armory buildings under other names, and workers trained at Robbins & Lawrence moved to other factories where they continued to innovate.

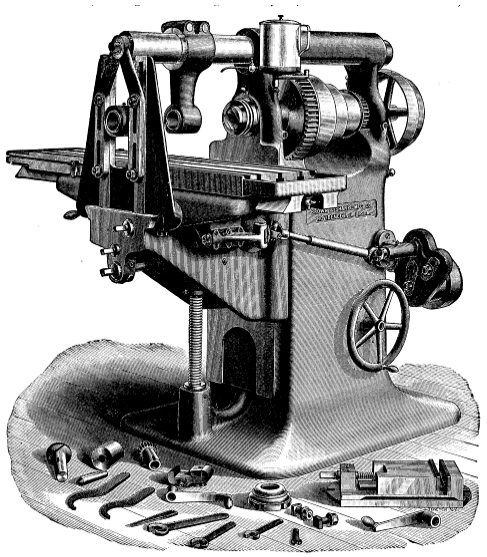
New Uses for Armory Practice



The American System was not confined to gun making for very long. Sewing machines may have been the first consumer product to be made using armory methods. In the 1850s, American inventors succeeded in designing machines that could sew straight seams far more quickly than a skilled seamstress could sew by hand. Each sewing machine was made of dozens of metal pieces. If those parts could be made by machine and could be interchangeable, sewing machines could be inexpensive enough for purchase by middle class families. And in new factories, rows of sewing machines could be set up so that low-skilled garment workers could quickly turn out ready-to-wear clothing. Fifty years after the first large textile mill was built in New England, there was finally a process of sewing that could keep up with the vast amount of cloth being turned out by weaving and spinning machines.

When the Civil War broke out, the armory in Windsor sold off its sewing machine business and went back to making guns and the machines to make guns. Additional gun-making equipment was sold to the government armories as well as to private arms makers, including the Amoskeag Manufacturing Company in Manchester, New Hampshire.[7] By this time the armory in Windsor had passed into the hands of the Lamson family, and at the end of the war E.G. Lamson began to expand the product line to a wide array of peacetime products. In the 1870s, the building was converted to a cotton mill employing young women to operate the looms, while across the brook, the business that would become the Jones & Lamson machine tool company was getting its start.

Over the years, the machinery, tools, and techniques developed for gun making took two different directions. First, an industry for making machine tools—the powerful machines that make other machines and tools—grew to be one of the most important industries in America. Second, these tools, machines, and techniques made possible an explosion of consumer goods. As new products were developed, machine makers worked with other manufacturers to solve production problems, working out new ways to cut and shape metal parts.[8] Sewing machines were followed by bicycles, which were followed by automobiles.



No. 8 PLAIN MILLING MACHINE.

Industrialization Changes Everyday Life

This industrial revolution had an enormous impact on communities in New Hampshire and Vermont. People moved from farms into mill towns. Many people who might have headed west to find better farmland stayed home, instead, and became mill hands. At first, in the 1820s, the mills were staffed by local families—sometimes entire families worked together in one textile mill. In some of the textile towns, factories were at first staffed by large groups of young women who came from New England farms to work for a few years before getting married. They lived in dormitories, bought fashionable clothes, and saved for their dowries. Some of them wrote poetry or learned to play the piano in their spare time. The factories and towns close to railroads grew, since their products could more easily be taken to U.S. markets and to harbors that would take them around the world. New schools were built, roads were improved, newspapers flourished, and shops provided more and more ready-made goods.

By 1840, a large influx of European and French Canadian immigrants began to provide a new pool of labor. The immigrants were willing to work for lower wages than the New England mill girls, and the work was speeded up both by decree from the mill owners and by developments in machine design. The young women drifted away, and their dormitories gave way to housing for immigrant families.

Anna Grenier at the Chase Cotton Mill in Burlington, Vermont, 1909.

By the 1920s, child labor began to fade, and more children went to school. As young people stayed in school longer, they developed skills and knowledge that made them more valuable in the job market. As American industry grew, the material world changed rapidly.

Accurate machining made it possible to create tight-fitting pistons and cylinders, and those pistons and cylinders made steam power work better. Then the pistons and cylinders made possible the gasoline-powered internal combustion engine. When Thomas Edison set up his “invention factory” in Menlo Park, New Jersey, he outfitted it with skilled machinists and machine tools as well as with scientists and inventors. Edison’s

group made important contributions to the telegraph, the telephone, motion pictures, and dozens of other new products and systems. When Henry Ford developed the moving assembly line and full-blown mass production of automobiles, he was essentially improving on a system that had been developed in the armories in the 1800s. When the Eastman Kodak Company developed the first consumer-grade box camera, the screws that held it together were made in quantity on screw-cutting lathes. When the first skyscrapers were built in New York, they included parts made by machine tools. Developments in agriculture and medicine have all resulted from advancing technology.

Not all effects of industrialization are good. Water and air pollution have damaged the natural environment. New weapons can be used for offense as well as defense. Although industrial agriculture, sanitation systems, and modern medicine have decreased human suffering, they have also dramatically increased the human population. And that increased human population has driven other species to extinction. Mass production, mass consumption, and the rapid development of consumer technology have created an enormous waste stream, but we have not yet figured out how to dispose of all of our trash. We need to think about how we use technology, and about how we can use it in the future to improve the world. We cannot simply dismiss it. We must understand it.

What does it all mean?

To begin with, we should understand the connection between industrialization and democracy. Our economic and political systems reward innovation. As machine work replaced skilled handwork, it became possible for unskilled workers to produce both necessities and luxuries; but the need for skill and innovation did not disappear. It moved from creation of the product to creation of new machines, new tools, and new systems of production. These innovations allowed lower skilled workers to produce an abundance of goods at affordable prices. Industrialization brought about a kind of democratization of food, clothing, medicine, books, tools, toys, and transportation. Today it is not just the wealthy who can afford a clock, or a telephone, or orange juice in the winter.

As you study the history of industry in your own community, you will be looking for ways in which industrialization changed your world. You can find these changes by looking in your own pockets, or by looking at the stores downtown, or by looking at the distant ridges with their relay stations and cell phone towers. You might also want to look toward the future. What new technologies need to be developed? Who will the next innovators be? How will their work change the lives of your children and grandchildren?

Notes

[1] Brooke Hindle and Steven Lubar, *Engines of Change: The American Industrial Revolution, 1790-1860*, (Washington, D.C.: Smithsonian Institution Press, 1986), 219.
[2] Guy Hubbard, *Windsor Industrial History*, (Windsor, Vermont: The Town School District, 1922), 6-7.
[3] Guy Hubbard, 9.
[4] Ruth Cowan, *A Social History of American Technology*, (New York: Oxford University Press, 1997), 80-81.
[5] Hubbard, 35, 39, 58.
[6] Richard Lawrence memoir, in Joseph Wickham Roe, *English and American Tool Builders* (New Haven: Yale University Press, 1916; rpt. Lindsay Publications, 1987), p. 286.
[7] Hubbard, 128-29.
[8] David Hounshell, *From the American System to Mass Production, 1800-1932*, (Baltimore: The Johns Hopkins University Press, 1984), p. 4.

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Cover: The Robbins & Lawrence Armory, from an old engraving, artist and date unknown, Collection of the American Precision Museum.
Page 1. Illustration from *Theatrum machinarium*, c. 1725, Library of Congress, Prints & Photographs Division, LC-USZ62-110460.
2. Water wheel in New London, CT, Historic American Buildings Survey, James Rainey, Photographer, May 10, 1936, courtesy of the Library of Congress, digital ID: http://hdl.loc.gov/loc.pnp/hhh.ct0196.
3. Clock parts illustrated in *Developpement de la montre à Roue de rencontre*, c. 1750-1809, Library of Congress, Prints & Photographs Division, LC-USZC4-1213.
4. 1847 Robbins, Kendall, & Lawrence rifle, photo by Frank Lather, collection of the American Precision Museum.
5. Detail from cover illustration, collection of the American Precision Museum.
6. Willcox & Gibbs sewing machine, photo by Frank Lather, collection of the American Precision Museum., Brown and Sharpe No. 8 Plain Milling Machine**,** *Manufacturer and builder*, Volume 24, Issue 7, p. 150, courtesy of Cornell University Library.
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Back Cover: Ascutney Shoe Factory, courtesy of the Windsor Historical Society.

Noon hour at a cotton mill in Bennington, Vermont.

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