



## INTRODUCTION

# Ideas, Invention, and Innovation

If you could go back in time a couple of hundred years or so, you'd find that the world was a very different place than it is today. Most people lived a farmer's life. They grew their own food and made almost everything by hand.



WORDS TO KNOW

**innovation:** a new invention or way of doing something.

**Industrial Revolution:** a time of far-reaching change when the large-scale production of goods began.

**manufacture:** to make something by machine, in a large factory.

**goods:** things for sale or to use.

**factory:** a place where goods are made.



It was very hard to keep in touch with people who lived far away. There were no cars, trains, or airplanes so travel was difficult. There were no telephones or telegraphs, so news had to be carried from town to town by travelers or messengers. People relied on themselves and their small communities.

But then things started to change. From the late 1700s through the early 1900s, many new ideas, inventions, and **innovations** dramatically affected the way people lived and worked. We call this period of great change the **Industrial Revolution**.

DURING THE INDUSTRIAL REVOLUTION, MACHINES STARTED DOING THE WORK OF PEOPLE. THESE MACHINES COULD **MANUFACTURE GOODS** FASTER AND MORE CHEAPLY THAN EVER.

Great **factories** full of machines sprung up in towns and cities, attracting workers from the farms. Steam engines and railroads carried goods to people who lived far away. Meanwhile, inventions such as electricity and the telephone transformed daily life, bringing people closer together. The Industrial Revolution began in Britain, but it soon spread to Europe and the United States.

WORDS TO KNOW

**profit:** to make money from business or investments.

**rural:** in the country.

**urban:** in the city.

**working class:** people who work in factories and in jobs using their hands.

**slum:** a run-down place to live.

**labor union:** a group of workers that bargains with the people they work for.

**bargain:** to work to reach an agreement.

**wage:** payment for work.

INDUSTRY IS THE PRODUCTION OF GOODS, ESPECIALLY IN FACTORIES.

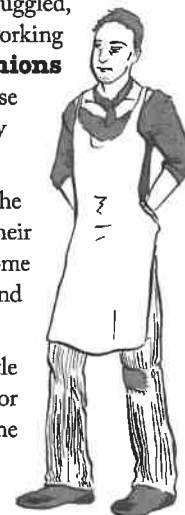
In many ways, the Industrial Revolution improved life for people around the world. It became easier to produce goods, communicate, and travel. Those who **profited** from the inventions and innovations of this age enjoyed wealth.

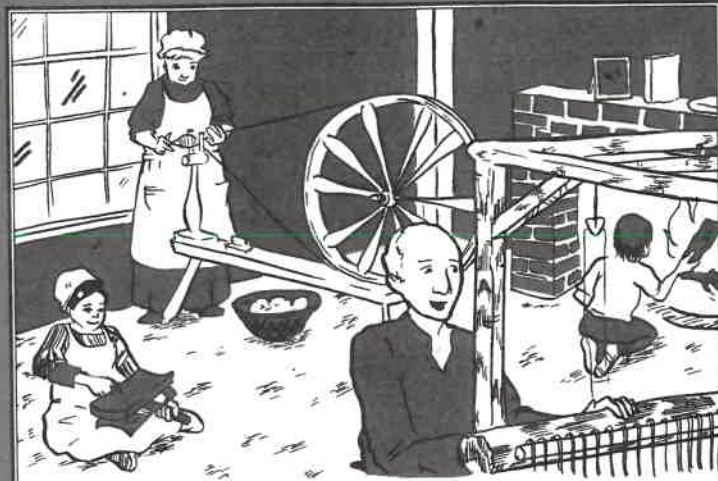
But for others, especially those who worked in the factories, life was not as easy. Many found the transition from a **rural** to an **urban** lifestyle difficult. The **working class** often struggled, living in filthy **slums** and working at dangerous jobs. **Labor unions** emerged to protect workers. These unions **bargained** with factory

owners for better working conditions and better **wages**.

This book will help you discover the legendary time of the Industrial Revolution. You'll learn about the inventors and their inventions, a little history of the time in which they lived, some interesting facts about the people and places around them, and how the Industrial Revolution changed everyday life.

Most of the projects in this book can be made with little adult supervision, using materials you already have at home or can easily find at a craft store. So get ready to step back in time and discover the Industrial Revolution!





## CHAPTER ONE

# A Revolution Begins with Textiles

In the early 1700s, **textiles** were made in people's homes. Cloth **merchants** brought wool, cotton, or **flax** fibers to spinners who worked at home. The spinners used a spinning wheel to spin the fibers into thread. Next, the merchants took the thread to a weaver, who used a loom to weave it into cloth. This cloth could then be sold at a market. Each step in the process was slow and required a lot of human labor. The entire process had changed little over the centuries.

At this time, there was a population explosion in England and Europe. More people meant a greater **demand** for cheap clothing. But home-based weavers and spinners worked too slowly to keep up with the increased demand. Cloth merchants realized that they could make a lot of money if they could speed up the cloth-making process.

THE TRANSFORMATION OF THE  
TEXTILE INDUSTRY BEGAN  
THE INDUSTRIAL REVOLUTION.

## WHY BRITAIN?

Why was the Industrial Revolution born in Great Britain? British inventors were the first to improve the textile and **mining** industries. They dug canals, built railroads, and created the world's first real factories.

Many historians believe that conditions in eighteenth-century Britain were perfect to launch the new machines, processes, and way of life of the Industrial Revolution. Britain had a large supply of **natural resources** like coal and iron that could be used in manufacturing. Britain also had many rivers that could move newly manufactured goods. In addition, Britain had a large labor force that could be put to work in factories. Finally, the British empire already had a strong system of banking, credit, and insurance. These tools made it easy for manufacturers to borrow and lend money easily and to do business with each other. ⊕

## WORDS TO KNOW

- textile:** cloth or fabric.
- merchant:** someone who buys and sells goods.
- flax:** a plant with blue flowers whose fibers are used to make linen.
- demand:** the amount that people want to buy.
- mining:** taking minerals from the ground, such as iron ore.
- natural resource:** materials that occur in nature, such as oil, coal, water, and land.

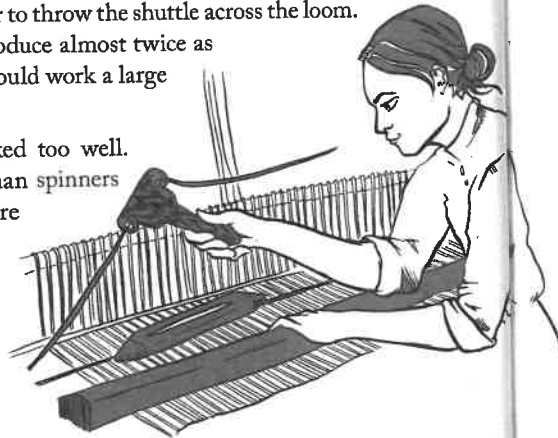
With this **incentive**, several **enterprising** Englishmen worked to build machines that could make cloth better and faster. The result was a series of inventions that transformed the entire cloth-making process, and made textiles the first industry to step into the Industrial Revolution.

- John Kay and the Flying Shuttle -

The flying shuttle was the first machine to **revolutionize** the textile industry. A shuttle was a needlelike device that weavers used to push thread from one side of a loom to the other. This was done by hand. If the looms were large, two weavers pushed the shuttle back and forth to each other.

In 1733, an Englishman named John Kay improved the weaving process by inventing a flying shuttle. Instead of pushing the shuttle by hand, a single weaver could simply pull a cord or lever to throw the shuttle across the loom. This allowed the weaver to produce almost twice as much cloth. A single weaver could work a large loom alone.

But the flying shuttle worked too well. Weavers used thread faster than **spinners** could spin it. So weavers were often forced to sit **idle**, waiting for more thread. Now cloth merchants had to find a way to speed up the spinning process.



WORDS TO KNOW

**incentive:** the possibility of a reward that encourages people to do something or work harder.

**enterprising:** willing to try a new, risky project.

**revolutionize:** to bring about a far-reaching change.

**idle:** not working.

- James Hargreaves and the Spinning Jenny -

James Hargreaves was an English weaver from Blackburn who was frustrated by the thread shortages. Historians believe he stumbled on the idea for a faster spinning machine when his wife accidentally tipped over her spinning wheel. The **spindle** landed in an upright position and continued to spin.

When Hargreaves saw the horizontal spinning wheel on the ground, an idea hatched in his mind. What if several spindles were placed upright and side-by-side? If such a machine could be built,

WORDS TO KNOW

**spindle:** the rod on a spinning wheel that twists the thread. The twisted thread is wound around the rod.

Hargreaves reasoned that it might be possible for a single spinner to work several spindles at the same time. This would dramatically increase the amount of thread a spinner could produce.

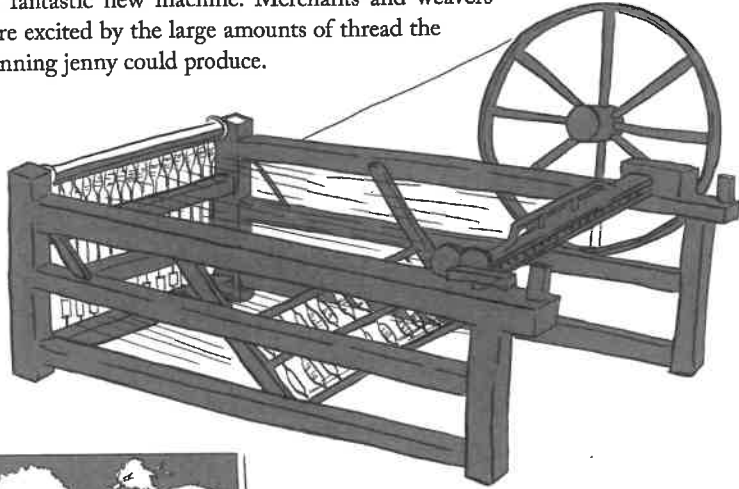
DID YOU KNOW?

Unmarried daughters usually spun yarn or thread in the family home. So the name "spinster" was commonly used to describe an unmarried woman.

FOR SEVERAL YEARS, HARGREAVES WORKED TO TRANSFER HIS IDEA INTO A WORKING MACHINE, WHICH HE NAMED THE SPINNING JENNY.

The jenny had six spindles placed on their sides. They were all attached to each other and turned by one large wheel. Instead of just one thread, this simple wooden machine spun several threads at once. Now one spinner could do the work of many!

At first, Hargreaves kept his spinning jenny secret. However, once he sold a few models for money, word quickly spread about his fantastic new machine. Merchants and weavers were excited by the large amounts of thread the spinning jenny could produce.



**NOT EVERYONE WAS PLEASED WITH HARGREAVES'S JENNY.**

Local spinners feared that the machine would take work away from them. An angry mob stormed Hargreaves's house, destroyed his workshop, and smashed all the spinning jennies they found. Afraid for his family's safety, Hargreaves left Blackburn and moved to the town of Nottingham.

In Nottingham, Hargreaves set up a new shop and obtained a **patent** in 1770 for the spinning jenny. Unfortunately, his patent was too late. Manufacturers were already copying the spinning jenny and refused to pay any **royalty** to Hargreaves. Soon, textile manufacturers were building spinning jennies with 20 spindles, and then 100 spindles!

**WORDS TO KNOW**

**patent:** a right given to only one inventor to manufacture, use, or sell an invention for a certain number of years.

**royalty:** money paid to the inventor of something to use or sell the invention.

IN THE END, HARGREAVES RECEIVED NEXT TO NOTHING FOR HIS INVENTION THAT COMPLETELY REVOLUTIONIZED ENGLAND'S TEXTILE INDUSTRY.

Richard Arkwright and the Water Frame

With all these inventions, the entire cloth-making process was much faster and cheaper. But weavers and spinners still complained about a shortage of thread. A traveling wigmaker, Richard Arkwright, saw the opportunity to make money in textiles. With the help of clockmaker John Kay,

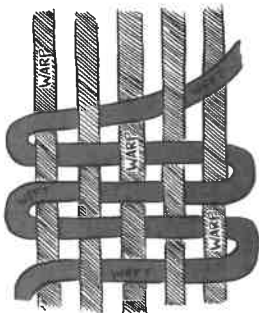
**DID YOU KNOW?**

Before John Kay's flying shuttle, a single home weaver could use the thread spun by two or three spinners. With a flying shuttle, the same weaver used the thread spun by eight or more spinners.



Arkwright set out to improve the mechanical spinning machine so that it could make stronger yarn with less labor.

Several years of work resulted in the invention of a large spinning machine that used a water wheel to turn wooden rollers at different speeds and twist **carded cotton** onto multiple spindles. The result was a stronger cotton thread that was perfect for **warp**.

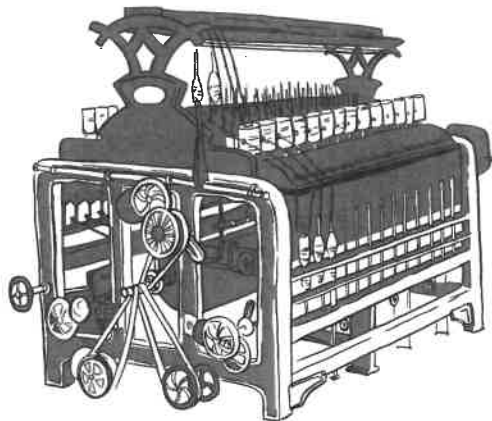


IN 1769, ARKWRIGHT RECEIVED HIS FIRST PATENT FOR THE WATER FRAME.

At the mill, Arkwright set up a brand-new system of divided labor, giving each worker a specific task. The tasks did not require much skill and kids as young as 10 worked at his mill. They worked from six in the morning until seven at night, with half an hour off for breakfast and 40 minutes for dinner. They got their education in church on Sundays.

DID YOU KNOW?

Many court cases challenged Arkwright's patents as copies of other inventors. There is still debate as to whether he truly invented the water frame, or simply found a good way to use it.



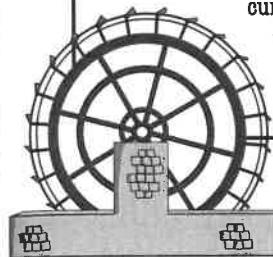
WORDS TO KNOW

**carded cotton:** cotton that is cleaned and brushed to prepare it for spinning.

**warp:** the strong thread that runs vertically in a loom.

THE NAME . . . WATER FRAME

After attempting to use horsepower to spin his machines, Arkwright built a factory on the riverbanks near Derbyshire. The force of the river's current turned a large paddle wheel that was connected to the spinning machines' crank. This waterpower gave Arkwright's spinning machine its name—the spinning water frame. ⊕



The mill operated for 23 hours a day. Arkwright's mill was the first factory of this kind in the world. Never before had people been put to work in such a well-organized way.

Never had people been told to come in at a certain time in the morning, and work all day at a specific task.

ARKWRIGHT BECAME KNOWN AS THE FATHER OF THE FACTORY SYSTEM.

As the demand for cotton thread grew, Arkwright built additional mills. Meanwhile, local spinners feared the changes that Arkwright and his mills brought. Angry mobs attacked his mills, burning a mill in Chorley to the ground. Yet Arkwright argued that his mills were important because they gave jobs to the working poor.

DID YOU KNOW?

When local spinners and weavers refused to work in Arkwright's factories, he hired poor children and orphans. By 1790, Arkwright's mills employed as many as 5,000 people.

Even though many people were afraid of the change, Richard Arkwright's factories transformed the textile industry. More than any other man, he combined power, machinery, and labor to create the modern factory system.

Seeing Arkwright's success, many wealthy businessmen invested in textiles, looking to make a large profit. Soon textile factories dotted the banks of rivers and streams throughout England. At first, the rivers powered the mill machinery. Eventually, factories would turn to another invention for power, the steam engine.



WORDS  
TO KNOW

**automated:** to operate by machine instead of human labor.

— — Edmund Cartwright and the Power Loom — —

In 1784, Edmund Cartwright visited one of Richard Arkwright's factories and watched machines spin thread faster and stronger than ever before. He realized that an **automated** weaving machine could further improve the cloth-making process. By 1785, Cartwright had a patent for his first version of a water-powered loom. His power loom could weave thread into cloth much faster than a home weaver could weave. It was also much larger than the typical home loom so Cartwright needed a factory to hold his looms. After making a few improvements to the power loom, Cartwright opened a weaving mill in Doncaster in 1787.

**SAMUEL CROMPTON  
AND THE SPINNING MULE**

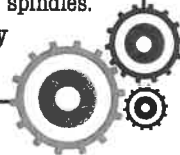
Even with these improvements in the cloth-making process, there was still one more problem preventing the manufacture of cheap clothes. Weavers had to use two different types of threads—cotton and linen. Cotton thread was cheaper, but it was weak, so linen thread had to be added for strength. To make clothes cheaper, someone had to find a way to make cotton thread stronger.

In 1779, Samuel Crompton invented a spinning machine he called the mule. The mule combined the moving carriage of the spinning jenny with the roller of the water frame. It spun strong, fine, soft yarn that could be used for all types of textiles.

Neighbors became curious as to what Crompton was doing to create such high-quality thread. Visitors stopped by his house at all hours, hoping to catch a glimpse of his machine. When some people tried to spy in his windows, Crompton put up screens to block their view.

Finally, the stress of trying to keep his secret became too much, so Crompton sold the rights to his invention to a manufacturer.

Soon textile manufacturers were building larger versions of Crompton's mule that had as many as 400 spindles. Crompton made no money from these sales. ⊕

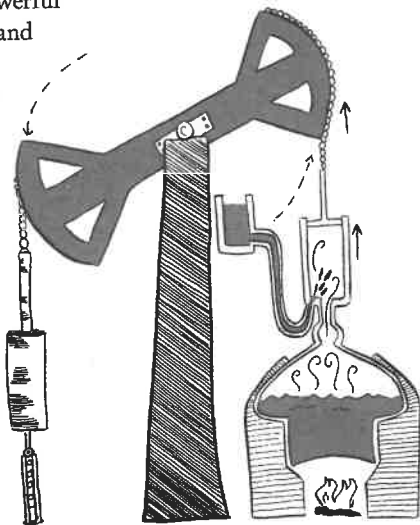


The Steam Engine

Using water to power machinery was a great step forward, but there was a problem. Factory owners could only build their factories near rivers and streams. To make it possible to build factories anywhere in England, a different power source was necessary. It had to be both inexpensive and reliable.

Some inventors believed that steam power was the answer. Thomas Newcomen had invented the first **commercially** successful steam engine in 1712. His engine burned coal, which heated water until it produced steam that was powerful enough to turn a machine's gears and **turbines**. Newcomen's steam engine was mainly used to pump water from coal mines, which allowed miners to dig deeper into the earth.

In 1765, a Scottish inventor and instrument maker named James Watt was asked to repair a Newcomen steam engine. While doing so, he realized that the engine was extremely **inefficient**. It lost too much steam as it worked.



WORDS TO KNOW

**commercially:** profitable, to be sold.

**turbine:** a machine with blades turned by the force of water, air, or steam.

**inefficient:** wasting time or energy.

Watt decided to make several changes to the steam engine. The result was an engine that produced more power from the same amount of coal. Together with his business partner, John Roebuck, Watt manufactured and sold steam engines. Soon all of England was steaming into the Industrial Age.

Changing Way of Life

With factories spreading across England, life began to change. Factories needed workers, and many people left their rural communities to work in towns and cities. Although these people were used to working long hours at home, working in a factory was much different. At home, workers could schedule their own hours and take breaks when they wanted to.

In a factory, supervisors kept workers on a tight schedule. Few breaks were allowed. Bosses told workers when it was time to eat or drink.

DID YOU KNOW?

A single steam engine could help produce as much thread in 12 hours as 750 human spinners could spin in a year!

MANY WORKERS FOUND FACTORY WORK TIRING AND BORING, BUT THEY NEEDED THE JOB TO SUPPORT THEIR FAMILIES.

**Entrepreneurs** from other industries saw how the textile business was booming because of factories. So they built their own factories. By 1800, England was home to factories **mass producing** items such as pottery, spoons, buttons, buckles, and teapots. It would not take long for the Industrial Revolution to spread to the rest of Europe and the United States.

WORDS TO KNOW

**entrepreneur:** a person who starts a business.

**mass produce:** to manufacture large amounts of a product.