The Allegheny Ridge Story

Centuries ago, American Indians identified one of the mountain ridges that crosses what is now central Pennsylvania as Allegheny, or endless. We don't know exactly who those Indians were; they could have been ancestors of the historic tribes that were eventually known as the Shawnee, Iroquois, or Delaware. But the word they chose to name the Ridge is still appropriate in describing not only the geography, but also the story of the Allegheny Ridge. The Allegheny Ridge State Heritage Park celebrates the people who live and work in this unique place. The Park is made up of a collection of people and places from whom you and your students can learn the amazing story of the Allegheny Ridge, a story that's been in the making for millions of years.

A Wrinkle in Time

When Continents Collide . It may sound like a sci-fi thriller from the 1950s, but "when continents collide" really does explain how the Allegheny Ridge was created. The Allegheny Ridge, also known as the Allegheny Front, is a 700-mile-long escarpment that stretches from north-central Pennsylvania to northern Alabama. It lies within the Allegheny Mountains, a series of uplands that make up the northern end of the Appalachian Highlands. The Allegheny Ridge is the eastern continental divide, separating the Valley and Ridge region to the east from the Appalachian Plateau to the west. It was formed about 250 million years ago, when the ancestral continents of Africa and North America collided. The force of this collision buckled the layers of rock into mountains and valleys. Wind, rain, and ice have worked to flatten these mountains, and have actually been somewhat successful, but their remnants survive, forming the unique landscape we know today.

10,000 Generations. The Allegheny Ridge has been home to thousands of people for at least 8,000 and perhaps as many as 20,000 years. American Indian camps and villages have been discovered along both sides of the Ridge throughout central Pennsylvania. The Ridge was an important landmark, as significant a navigational guide to these early travelers as the compass was for later visitors to North America. The Ridge may have served as an unmistakable boundary between different prehistoric Indian cultures. The Indians developed an extensive network of trails along, around, and over the Ridge that was so well-conceived that many of the roads and railroads we use today still follow these prehistoric trails.

Colonial History. By the 18th century, Europeans followed the rivers inland from the East Coast to the eastern slope of the Ridge. Since the Ridge is the continental divide, water transportation over it was impossible — water flows away from it toward the east and west. The eastern face presented quite an obstacle to anyone transporting more than a backpack, since the foot trails up the Ridge were narrow and steep. For many early homesteaders, the Ridge presented too great a challenge — they could cross it, but obtaining supplies from the east, or carrying crops and products to market would be difficult if it involved a trip up or down the Ridge. They stopped at the foot of the mountain, in places like Frankstown and Bedford, where the branches of the Juniata River provided better access to markets and supply depots back east.

There were people west of the Ridge, but many of them got there by taking the long way around. The ancestors of the historic Indians of the Ohio Valley had the longest trip, migrating to North America by way of Siberia and Alaska. Continental ice sheets locked up much of the earth's water and revealed dry land where there had been only sea for thousands of years. They successfully colonized not only North America, but also Central and South America. By the 18th century, they had already been here for about 20,000 years.

Ready for a Fight. The French and other newcomers got around the Allegheny Front by coming down from the Great Lakes to the confluence of the Allegheny and Monongahela rivers at what is now Pittsburgh. A few Virginians crossed the Ridge through gaps in what is now West Virginia and Maryland and settled in western Pennsylvania. They considered much of the area west of the Ridge to be Virginia, regardless of what the Indians, the French, or even the Penns, the legal proprietors of the land, thought. With all these different people claiming the area, there was bound to be a fight.

There were, in fact, many fights in the decades leading up to the American Revolution. Indians fought Indians, the French fought the Virginians (a British colony), the Virginians fought the French and the Indians. East of the Ridge, places like Bedford and Carlisle became supply depots where men and materials could be collected for the trip over the Ridge. New roads were needed, and soldiers like Edward Braddock and John Forbes built the roads that still bear their names. By the time of the American Revolution, there were many seasoned fighters along the Ridge.

During the American Revolution, the people who lived along the Ridge experienced a very different war than their contemporaries closer to the Atlantic coast or along the major rivers. Instead of large battles of uniformed soldiers, artillery, and big forts, the people of the Ridge used guerrilla tactics and fought hand to hand with their Tory neighbors, British Rangers, and the King's Indian allies. Forts on the frontier were few, but most people had access to specially fortified houses and barns. Not far from the eastern slope of the Ridge, Fort Roberdeau was garrisoned by patriot rangers and provided a haven when British Rangers and their Indian allies threatened.

Industrialization along the Ridge. By the late 18th and early 19th centuries, most of the fighting had stopped. More people came to live near the Ridge. Farmers cultivated the valleys while others extracted iron ore, limestone, coal, and other minerals from the mountains and uplands on both sides of the Ridge. Industrialization prompted the need for better transportation, and by the 1820s, engineers looked for an efficient way to cross the Ridge.

Transportation Improvements. An engineer in England had recently put a steam engine on wheels and had successfully moved freight and passengers on a road of rails. A few small railroads were already working in North America, in cities along the relatively flat coastline. Railroads were a novelty and, to many 19th-century Easterners, did not seem to have much of a future, since canals could efficiently move people and freight between most cities along the East Coast.

Go West. Most people were quite content with the growing canal system. But the Louisiana Purchase in 1803 had doubled the area of the United States, and many would-be homesteaders set their sights on the west. They migrated from the East Coast by the thousands in the first half of the 19th century. Folks were on the move, and the places that they traveled through prospered by providing goods and services to this transient crowd. Pittsburgh, at the forks of the Ohio River, became an important manufacturing center, but the only way to get many of its products to eastern markets was by way of the Ohio River to the Mississippi, then to the Gulf of Mexico, around Florida, and up the East Coast. There had to be a better way.

Canals were the most efficient means of transportation known at the time, but no canal, no matter how skillfully designed, could ever be constructed across the Allegheny Ridge. (Remember, the Ridge is a *continental divide,* so water flows *away* from it. This is a real problem if you're trying to fill a canal. There just isn't enough water to float a boat!) Optimism that a solution would be discovered reigned, and work began on the construction of the Pennsylvania Canal on both sides of the Ridge. A portage was needed between the canal terminals at Hollidaysburg and Johnstown. The engineers' solution was the Allegheny Portage Railroad.

The Allegheny Portage Railroad

The Allegheny Portage Railroad (APRR) was remarkable. Railroad building was a new and experimental venture in the early decades of the 19th century; there were only about 23 miles of railroad in all of North America. The construction of the 36-mile long Allegheny Portage Railroad more than doubled the miles of track on the continent. The railroad consisted of ten inclined planes connected by stretches of level track. Steam engine technology had not yet developed to the point where any locomotive was powerful enough to pull a load up any more than the slightest incline, so the Allegheny Portage Railroad was designed using stationary steam engines at the top of each plane to raise and lower the cars. Cars were tied to a rope that wound around large pulleys, or sheaves, at the top and bottom of the plane. On the levels between planes, cars were pulled by animals, and later, locomotives. It was a tedious operation, requiring the cars to be hitched and unhitched to a different power source at the top and bottom of each plane. Despite this, the combination of canal and railroad across Pennsylvania successfully moved people and freight across the state until the mid-19th century.

This significant advancement in transportation across Pennsylvania began in 1826. The Pennsylvania Legislature authorized the development of a combination canal and railroad system which would connect Pennsylvania's largest cities, Philadelphia and Pittsburgh. Construction began simultaneously at both ends in 1826, and was completed eight years later in 1834. The Pennsylvania Mainline was built to compete with New York's Erie Canal, which opened between Albany, New York, and Buffalo, New York, in 1825, and with the Chesapeake and Ohio (C & O) Canal, from Washington to Cumberland, Maryland, completed in 1850. Like the builders of the Pennsylvania Mainline, the builders of the C & O Canal also had to deal with crossing the Allegheny Ridge. Their solution was to connect the canal with the National Road at Cumberland, Maryland. The Erie Canal, the C & O Canal, and the National Road threatened to leave Pennsylvania far behind her northern and southern neighbors in the development of commerce and westward expansion.

The Pennsylvania Mainline. Traveling from east to west, a trip on the Pennsylvania Mainline started in Philadelphia. A rail line carried freight and passengers from Philadelphia to Columbia, a small town on the Susquehanna River below Harrisburg. At Columbia, freight and passengers were transferred to a canal boat and floated along the Susquehanna and Juniata rivers. A system of *locks and dams* raised and lowered the boats around shallows and rapids, and the boats were towed by mules or horses, steadily climbing until they reached the eastern slope of the Allegheny Ridge at Hollidaysburg. Freight and passengers were transferred to a rail car for the trip over the planes and levels of the Allegheny Portage Railroad. At Johnstown, on the foot of the western face of the Allegheny Ridge, freight and traffic were loaded once again onto canal boats and towed along the canal to Pittsburgh.

Over the Ridge. The most difficult aspect of the Mainline was the route over the Allegheny Ridge. Between Hollidaysburg and Johnstown, the Allegheny Ridge rose to more than 2,340 feet above sea level. The summit of the Ridge was 1,387 feet above Hollidaysburg (elevation 953 feet above sea level) and 1,157 feet above Johnstown (1,183 feet above sea level). Rather than build a wagon road, the engineers decided on a system of inclined planes and levels to raise and lower passengers and freight over the Ridge. The Allegheny Portage Railroad was an overland connection between the drainages of the Juniata and the Conemaugh rivers.

On the western slope of the Ridge, between the summit (near Cresson) and Johnstown, were five inclined planes and five levels. On the eastern slope, between Hollidaysburg and the summit, were five more inclined planes and five more levels. The inclined planes were identified by number. Plane 1 was the westernmost, just above Johnstown; Plane 10, the easternmost, was a few miles west of Hollidaysburg. The Summit Level connected Planes 5 and 6 on top of the Ridge. Altogether, the Allegheny Portage Railroad consisted of ten planes and eleven levels.

APRR Operation. In the hitching shed at the foot of each plane, workers attached uphill cars to a hemp rope. The rope wound around a large pulley, or sheave, at the bottom of the plane, ran between the rails of the uphill track to the engine house, wound around three more sheaves beneath the engine house, and ran back down to the foot of the plane between the rails of the downhill track. The sheaves were turned by a stationary steam engine in the engine house at the top of the plane. The ropes often broke and were a constant source of trouble, anxiety, and expense. At the top of the plane, workers detached the cars from the rope and attached them to a horse or mule team (eventually replaced by a steam locomotive) for the trip along the level to the hitching shed at the foot of the next plane.

The safety of passengers and freight on the APRR was much improved after 1849 when the hemp ropes on the planes were replaced with wire ropes. The wire ropes consisted of strands of steel wire wound tightly together. The process for making this wire rope was developed in 1842 by John Augustus Roebling, the engineering genius who later used wire rope in the construction of the Brooklyn Bridge in New York City.

When the APRR opened, cars were pulled by teams of horses or mules along the levels. In 1835, these animals were replaced by steam locomotives on some of the levels. Eventually, locomotives were used on all the levels. The 36-mile trip between Hollidaysburg and Johnstown took from six to eight hours, including a stop along the way for a meal.

Track and Rails. The original railroad on the levels consisted of a single track mounted on stone blocks, called *sleepers.* The sleepers were about two feet square, 18 inches thick and weighed about 500 pounds each. The sleepers were placed about twelve to fifteen inches apart under each rail. On top of each sleeper, two holes were hand-drilled, and fitted with cylindrical plugs, usually of locust wood. Iron *rail chairs* were positioned over the plugs and spiked into place on the sleeper. The rail was placed in the chairs and secured snugly with small iron wedges. The rail was known as *T-rail* because it was somewhat T-shaped in cross-section, with a wide surface supported by a narrow base that fit into the chair. Both the chairs and the rails were initially imported from England, but eventually American ironworks and foundries provided them. When the APRR opened, most of the levels had only one track. By 1835, a second track was completed on all the levels.

The disadvantages of the sleeper system became apparent almost immediately. As heavy cars and locomotives moved across them, the sleepers loosened and moved out of position. Drainage along the levels was also a problem, and water-logged soils gave way, causing the sleepers to move or sink. Frost and severe winter weather, common along the Allegheny Ridge, also moved the sleepers out of place, ruining the uniform 4' 8½" *gauge.* (The gauge is the distance between the pair of rails.) The engineers realized that they needed a way to tie the tracks together, so that they could not move independently. Stone cross-ties, and later, wooden ties, were added to maintain the gauge, particularly on curves.

A different type of rail, known as *strap rail,* was used on the planes. Strap rail consisted of a thin, narrow piece of iron attached to the top of a long wooden beam called a *stringer.* The stringers were supported on wooden cross-ties. The strap rails were attached to the stringers by spikes driven through small holes drilled through the rail. Sections of strap rail were placed end to end along the inside edge of the stringer. Sometimes, the weight of the cars loosened the spikes. When this happened, the rail sometimes sprang loose with enough force to penetrate the bottom of the car and enter the freight and passenger compartments. These "snakeheads" were very dangerous, and could result in serious injuries.

The Skew Arch Bridge. Several special engineering feats were needed along the APRR. The railroad paralleled the route of the Huntingdon, Cambria, and Indiana Turnpike along the eastern slope of the Allegheny Ridge. In order to keep this important road open, a bridge was needed to carry it across Plane 6. This bridge, however, presented a challenge. Unlike most bridges, it had to be built on a steep hill. This required a bridge that would be able to support the weight of traffic on the turnpike without tumbling down the slope. The engineers knew that arches were very strong, so they designed a "skewed" arch for the bridge.

The Skew Arch Bridge actually consists of two arches, perpendicular to each other. One supported the traffic on the bridge, the other kept the bridge from sliding down the Ridge. To accomplish this, very skilled stone masons cut and carefully dressed the sandstone blocks so that they fit snugly together, without mortar. The engineers and masons did a good job. After more than 160 years, the Skew Arch Bridge is still standing, and is preserved by the National Park Service in the Allegheny Portage Railroad National Historic Site.

The Staple Bend Tunnel. The APRR also had one of the earliest railroad tunnels in America. On the western slope of the Ridge, just above Johnstown, near the later mining community of Mineral Point, an elevated point of land diverted the course of the Little Conemaugh River into a broad curve. This curve, resembling a staple, was known as the Staple Bend of the river. At the Staple Bend, the engineers were faced with two options. They could build the track by clearing and digging a long, wide ledge around the side of the point of land overlooking the river, or they could dig a tunnel through the point. They decided to dig the tunnel. The Staple Bend Tunnel was 901 feet long, 20 feet wide, and 19 feet high. At both ends, it was arched with cut stone for a distance of 150 feet. The engine house for Plane 1 was located at the western end of the tunnel. The Staple Bend Tunnel was acquired by the National Park Service in 1996.

Planes to Trains. The APRR was an engineering marvel, but advancements in railroad technology in the nine years it took to build it made the APRR nearly obsolete by the time it opened in 1834. By the 1850s, more powerful steam locomotives were developed capable of pulling loads up slight hills. It was a new way to think about railroads, since mountains could now be crossed by the construction of steadily climbing tracks that wound back and forth up the steep terrain. Tunnels through the summit eliminated other steep climbs. The planes of the Allegheny Portage Railroad could now be avoided by the construction of winding tracks and tunnels across the Ridge. It was no longer necessary to stop and change power at the top and bottom of ten planes to get across the Allegheny Ridge — one or two locomotives could now do the work that had required ten stationary steam engines and eleven locomotives. Fewer machines meant fewer chances for breakdowns and increased efficiency.

Despite the heavy freight and passenger traffic on the APRR, the high cost of its construction and operation prevented this pioneer railroad from being profitable. Competition from private railroad companies, especially the Pennsylvania Railroad (PRR), were too much for the state-owned Pennsylvania Mainline. The state made an effort to compete directly with the PRR, and completed the New Portage Railroad in 1855. But the PRR was too efficient, and in 1857 the New Portage Railroad was purchased, and closed by its competitor, the PRR. Some sections of the canal remained open for a few more years, but by the end of the century, almost the entire Mainline had been abandoned.

Although the Pennsylvania Mainline itself was not a financial success for the Commonwealth of Pennsylvania, it played a significant role in the economic development of the region it crossed, including Blair and Cambria counties. Hollidaysburg and Johnstown, at both ends of the APRR and the Juniata and Western divisions of the Pennsylvania Canal, respectively, as well as the communities of Duncansville, Cresson, Lilly, Portage, Wilmore, Summerhill, and South Fork, all benefited from the traffic, the employment, and the access to distant markets afforded by these lines.

Gotta See It! APRR and PA Canal Sites

The Allegheny Portage Railroad National Historic Site. A good place to learn the story of the APRR is at the Allegheny Portage Railroad National Historic Site near Cresson. This National Park has exhibits and people that explain the importance and operation of the APRR.

The Hollidaysburg Canal Basin. The Gaysport neighborhood of Hollidaysburg was the site of the canal basin and the eastern end of the APRR. The basin and its locks have been filled, and are now privately owned. Part of the basin is now the railyard. A walk along Juniata Street, past the US Hotel (a canal era building), provides an opportunity to look out over the site. Students should not trespass, especially in the railyard, since moving trains present a very immediate danger. The borough of Hollidaysburg also has many other canal era structures. The Main Street Manager in Hollidaysburg can provide information on the architecture and walking tours of the town.

The Johnstown Canal Basin. The canal basin in Johnstown was located in the Conemaugh section of the city, near the American Hotel, a canal era building. There are fewer surviving structures from the canal era in Johnstown than there are in Hollidaysburg, mostly because of destruction caused by the floods of 1889 and other years. The Johnstown Area Heritage Association can provide information.

The Lower Trail. The Lower (rhymes with flower) Trail is a Rails-to-Trails project in Blair County. This means that an abandoned railroad grade has been developed into a recreational trail. The Lower Trail is a good place to look at the remains of many industries, including the Pennsylvania Canal. There are several canal locks and dams that you can walk to and investigate. Contact Blair County Rails-to-Trails for more information.

The Path of Progress National Heritage Route. Some features of the APRR can be accessed by car on the western slope of the Allegheny Ridge. Planes 2, 4, and 5 now lie on existing roadways near Portage, Lilly, and Cresson, respectively — you can actually drive up and down these (or portions of these) planes, and the levels between them, by following the Path of Progress. For more information, contact the Southwestern Pennsylvania Heritage Preservation Commission.

The Pennsylvania Railroad

The Commonwealth of Pennsylvania lost money during its operation of the canals and railroad, but with the rapidly improving technology, it began to look as if railroad transportation could be profitable. Private investors became interested, and the Pennsylvania Railroad was chartered. The first all-rail line (no canals, no inclined planes) crossed the state in 1854, when the Pennsylvania Railroad completed the Horseshoe Curve on the eastern slope of the Allegheny Ridge near Altoona.

In the mid-19th century, merchants in Philadelphia became increasingly alarmed by the rising commercial competition they faced from merchants in New York and Baltimore. Like Pennsylvania, New York and Maryland built rail and canal systems to transport people and goods. In Pennsylvania, the Mainline Canal and Allegheny Portage Railroad proved that passengers and freight could be moved across the rugged geography of the state, but at a high cost. Operation and maintenance costs, as well as restrictions on the length of the travel season imposed by poor winter weather, conspired to prevent the state from realizing a profit on its venture, despite the high volume of traffic the Mainline carried.

The State Tries Again. In 1846, the merchants of Philadelphia and Pittsburgh were convinced that the state could not run an efficient transportation system. They worried that without a reliable railroad, their businesses would fail. Some legislators thought that the state could, and should, build and operate an efficient and cost-effective railroad; they pushed for the construction of the New Portage Railroad. This new railroad would avoid the canals and planes of the Mainline while following approximately the same route.

Birth of the PRR. The merchants were able to compel the state assembly to find a private company to build a railroad between Philadelphia and Pittsburgh. The Pennsylvania Railroad (PRR) was chartered, and J. Edgar Thomson was hired as chief engineer. Thomson supervised an intensive survey across the Pennsylvania landscape. He determined that a railroad route across central Pennsylvania was possible, but it would require some outstanding engineering features to accomplish. Engineers working on the state's New Portage Railroad had discovered the same thing, and plans for both roads proceeded simultaneously.

Good-bye, APRR. Construction of the state's New Portage Railroad moved slowly. While construction of the line over the Allegheny Ridge continued, traffic on the Mainline continued to use the planes and levels of the original Allegheny Portage Railroad, now dubbed the "old" Portage Railroad, until all of the planes were avoided. The last plane to be closed was Plane 8, the steepest. It was avoided by the construction of the Muleshoe Curve, a wide curve at the eastern foot of the Allegheny Ridge.

A Public-Private Partnership. Construction of the PRR also progressed across the state, beginning in 1847. Unlike the New Portage Railroad, built at taxpayer expense, money to finance the PRR came from the sale of stock to private investors. On September 1, 1849, a segment of the PRR's Eastern Division opened between Harrisburg and Lewistown. By 1850, construction of the PRR's Eastern Division was completed to the base of the eastern slope of the Allegheny Ridge.

Near the ridge, the routes of the PRR and the New Portage were only a few miles apart. A deal was worked out between the two lines that allowed the PRR to divert its traffic to the New Portage Railroad while it continued work on its line over the Ridge. The two lines joined just west of Hollidaysburg, at an intersection known as Portage Junction, and later the Wye Switches. West of the summit, PRR traffic was switched back to the PRR's Western Division.

Thomson Builds a Curve. With this temporary link established, Thomson turned his attention to the Mountain Division that would carry the trains over the Allegheny Ridge. Thomson knew that locomotives could not pull trains up very steep grades; the track could rise no more than two feet for every 100 feet of horizontal run. He surveyed and mapped a route that never exceeded a grade of 1.8 percent, or a rise of 1.8 feet every 100 feet. He did this by bringing the track steadily up the Ridge from Altoona, along the beds of small streams, and by cutting the trackbed into the side of the Ridge, like a shelf.

About five miles west of Altoona, at Kittanning Point, the swiftly flowing waters of Burgoon Run and Kittanning Run had cut deep and narrow ravines into the ridge. To maintain the 1.8 percent grade, Thomson had to cross these streams and get around Kittanning Point. Rather than build bridges, Thomson devised a plan to fill the ravines with rock and earth, and to cut back the rock face of the point. Because the resulting curve of the track resembled the shoes of the draft animals that helped build it, this tremendous engineering feat was called the Horseshoe Curve.

Handmade?! In the mid-19th century, there were no giant bulldozers or hydraulic excavators that could move tons of rock with each cut. There were no enormous dump trucks capable of hauling twenty-ton loads. There were picks and shovels, wagons and wheelbarrows, and a little black powder. These tools were deftly wielded by 450 Irish miners specially hired for the job. They built the Horseshoe Curve by hand.

If Not Over, Then Through. At the top of the mountain, in Gallitzin, tunnels were excavated for both the PRR and the New Portage Railroad. The tunnels eliminated the need to lay track over the steep and narrow summit of the Allegheny Ridge.

Good-bye, New Portage RR. The PRR's Mountain Division opened on February 15, 1854. Pittsburgh and Philadelphia were finally connected by a railroad. The new line was enormously successful — so successful, in fact, that the PRR bought out its nearest competitor, the state-owned New Portage Railroad, in 1855 and by 1857 had totally shut it down. The state line had continued to lose money. Thomson's plan was brilliant, and the continued use of his grade over the Allegheny Ridge for more than 140 years is a testament to the skill and workmanship of its designer and builders.

The Railroad City. The PRR decided to build its headquarters in the town of Altoona, at the eastern foot of the Allegheny Ridge, in 1849. Hundreds of acres of farmland eventually became railroad yards.

The shops and yards of the PRR expanded throughout the second half of the 19th century. Eventually, the complex became the largest in the world, covering about 300 acres. People came to Altoona by the thousands to work for the railroad, and the PRR became the nation's largest corporation. Its high standards became models for other businesses and industries.

A New Way to Work. As the workforce grew, a new work culture developed characterized by a need for standardization. With the increasing use of machinery, there was a need for stricter labor discipline. This meant that workers had to function in ways and on schedules that increased the efficiency of the machines. Their time was not their own. The change from an agrarian society to an industrial society meant that workers and management alike had to go through a restructuring of work patterns. The slower, pre-industrial agrarian work attitudes and routines did not serve industrial capitalism well.

The railroad work culture was characterized by increasing numbers of regulations for workers, frequent job changes by workers within the railroad organization to get better-paying positions, increased specialization of jobs, lengthy careers, personnel policies influenced by ethnicity and race, and the creation and use of an occupational language known particularly to those people associated with the railroad.

Rules and More Rules. In the early days of the railroad, managers and new recruits developed processes which increased efficiency. In the first two decades of American railroad development (1830-1850), new employees were given a single sheet of paper with timetables on one side and work rules on the other. By 1870, the process had become much more complicated, and rail companies distributed lengthy, leather bound rule books to all employees. These books contained rules for following authority, rules for how to do specific jobs, and very strict rules about personal behavior.

Climbing the Ladder. Once hired, most railroaders expected that they would change positions or be promoted several times throughout their careers. Usually, railroaders stayed within one of the three areas of railroad work: on the mainline, in the shops, or in the offices. A railroader initially hired to work on the mainline might move up within the jobs on the mainline, but rarely would shift to the office or the shops. It is impossible to characterize typical job movement for every railroad worker — there were certain conditions under which promotion might or might not occur. These conditions also changed over time.

Railroad companies prided themselves on the fact that they had multiple generations of workers from one family. There were also large numbers of workers who were employed for short periods of time. Statistics on job movement are difficult to assess, but the following pattern for the period from 1850-1900 is typical: laborer at age eighteen, fireman at twenty-one, freight locomotive engineer by twenty-six, and passenger locomotiveman by thirty-five.

Some railroaders were more ambitious, and climbed the promotion ladder more quickly. Other important factors in the speed of promotion included the railroader's father's occupation, and his own marital status. Sons of businessmen, professionals, and skilled workers advanced more quickly than did the sons of farmers and unskilled laborers. Single men advanced more slowly than married men.

Big Bosses. The growth of the railroad led to changes in the way that American business and industry was organized and managed. Railroad companies acquired and invested in other businesses and industries that could increase their profits, such as coal mines, steel mills, and subway and trolley lines in urban areas.

By the late 1880s, the boards of many of the nation's largest railroad, steel, and coal companies shared members. This was a very effective way to control commerce along the new rail lines, to regulate the movement of people and goods along the east coast and eventually across the country, and to capture the labor force. Because of the cross investments and shared board members, the development of the nation's heavy industry was in fact being run by a handful of increasingly wealthy owners. Their industries created an unprecedented demand for larger and larger numbers of workers.

Shop Around. Much that has been written about railroaders concentrates on the trains and the men who ran them, but there is an equally important story in the work of the shop workers. These were the men who designed, made, or repaired the locomotives and cars. This work was done in many types of shops by skilled men doing many different jobs.

Locomotives and cars were brought to the shops to be checked and repaired, and for general maintenance. There were shops that dealt with specific problems, such as trucks (term used for the wheels and axles), electrical needs, body work, frame work, engines, carpentry, bearings, boilers, and brakes. Railroaders learned their skills by working as apprentices.

Bosses and Beancounters. The administration and management of the railroad required a multi-tiered staff. At the top of this hierarchy were the shareholders, the board of directors, and the president. Below them were vice presidents in charge of specific tasks, and below the vice presidents, a great number of salesmen, accountants, clerks, and other more specialized office staff.

Workin' on the Railroad. Many railroaders worked on the mainline. There were hundreds of jobs filled by hundreds of thousands of railroaders. Railroaders on the mainline ran the trains, attended to passengers, and maintained the "way," or tracks. Jobs on the mainline included brakemen, switchmen, conductors, firemen, and locomotive engineers.

The railroaders who worked on the lines and in the yards were responsible for the actual movement of the train. The yardmen inspected each car and were responsible for assembling cars into trains. They were also responsible for switching cars and signaling to other yardmen as the cars moved across the yard. They made sure that the locomotive was in excellent condition and ready for its trip.

No Girls Allowed. Most 19th century railroaders were men. Few women were hired until the early 20th century. Women with high school diplomas were given low-paying jobs in the offices. During World War II, many women were hired on the mainline and in the shops and yards while the male railroaders were off at war. After the war, the soldiers returned to their jobs and the women were laid off.

Where're You From? Prior to 1870, the first railroaders came from many ethnic backgrounds and social situations. On New England railroads, the Irish dominated the lists of laborers. In the Midwest, many railroaders were German. Before the Civil War, black slaves kept southern trains running. Throughout the United States, many of the early locomotive engineers were English, since many of the locomotives were imported from England.

In Pennsylvania, according to information collected from documents in Philadelphia, native-born white males dominated the railroad labor force. These workers included many Pennsylvania-born Germans who gave up farming to work for the railroad. About 80 percent of the railroaders in Philadelphia between 1860 and 1880 were descendants of English colonists, even though they made up only about 50 percent of the entire population. Irish immigrants made up about 15 percent of the work force (25 percent of the population), recently arrived German immigrants about 3 percent (about 13 percent of the population), and African-Americans less than 1 percent (about 5 percent of the population).

Unequal Opportunity. Not surprisingly, native-born white males also dominated the administrative and management positions of the railroad. In 1880, white males held 40 percent of the office jobs, while Irish men held 25 percent and Germans 18 percent. No African-Americans had white collar jobs. A strong association between ethnicity and position clearly existed in the early years of the industry.

By 1880, the industry had become more flexible. Irish and German men now held upper and lower management jobs in nearly the same proportions as their English counterparts. Second generation immigrants experienced greater access to positions than their parents and grandparents. A notable exception to this was the lack of opportunity for African-Americans in positions like porter, and other service jobs.

Say What? Throughout the history of railroading, a rich occupational folklore has been created. Occupational folklore focuses on work-related jargon and narratives, the customs and traditions associated with learning a new job, and the actual skills and techniques which are informally learned and performed by a worker in any job.

The way people talked about their lives and their work created the opportunity to make connections with people who were in similar situations or who did the same kind of work. Learning the occupational jargon of a specific job or industry was critical for successful communication "on the job." Railroaders used words and phrases that made the job easier to teach to new employees. The use of special work-related words and phrases also showed new employees just how little they knew, and helped promote a sense of community among the railroaders. Many present-day occupations also have distinctive languages.

The sense of community among workers was maintained by the selective use of occupational language. Those who knew it were in; those who didn't, were out. Workers' language on the job also distinguished administrators and managers, the "white collar workers," from the "blue collar workers." People spoke differently with co-workers than they did with supervisors. Occupational language is a means to understand the smallest details of everyday work experiences on the job.

Railroads and Steel. Railroads like the PRR were a great improvement over the canal and portage railroad. The fledgling iron and steel industry in Johnstown relied entirely on the canal in the first half of the 19th century to get its products to market. When the PRR opened, Johnstown steelmakers not only got year-round access to more markets, they also got one of their biggest customers — the railroad.

Railroads and Coal. The Mainline of the PRR came up the Ridge from Altoona, passed through the tunnels at Gallitzin, then went directly through Cresson, Lilly, Portage, Wilmore, Summerhill, South Fork, and Johnstown. By the mid-1890s, coal mining in northern Cambria County prompted the construction of spur lines to Carrolltown, Hastings, and Patton. These spurs hauled coal, freight, and passengers.

Smaller railroads were developed to serve local markets. They were often owned by steel or lumber companies who found that they could make their operations more profitable by controlling not only production, but also the methods needed to deliver raw materials to their mills. An example of one of these small railroads is the Cambria and Indiana Railroad. It started in 1904, and hauled lumber in northern Cambria County. By 1910, the C & I Railroad had rail connections for hauling coal from Vintondale, Nanty Glo, Colver, Revloc, and Pine Flats. It continued to expand until about 1917 by building new branches between mines and communities west of the Ridge. The railroads were intimately linked to the success of the coal industry — with the railroads, coal from the Ridge could be distributed throughout the United States. It could easily be shipped to seaports and taken on by steamships as both fuel and freight and carried throughout the world.

What Goes Around Comes Around. Local passenger and freight service along the Ridge was an important part of the railroad business until World War II. Improved highways, the availability of automobiles, and the advent of air travel diminished the need for local and long distance rail connections. Passenger service is now limited to major cities throughout the United States. The railroads still haul coal, some steel, and some freight, but most freight is now hauled on the highways by trucks. The railroads have met a fate similar to the canals and portage railroad — they have been replaced by other technologies.

Industrial Boom. Towns and cities along the Ridge continued to grow during the second half of the 19th century. The Civil War, followed by a burst of westward expansion, created a demand for the products that the workers of the shops and mills of Altoona and Johnstown produced better than anyone else anywhere. Rail, wire, and other products of Johnstown's Cambria Iron Company literally spanned the continent; the Pennsylvania Railroad, headquartered in Altoona, became the world's largest corporation. Coal mining communities like Windber fueled this industrial revolution in a very literal sense.

The hills around Johnstown held valuable deposits of coal and iron ore. With the construction of the Pennsylvania Mainline in the 1830s, Johnstown was connected to important markets and sources of raw materials by way of the Western Division of the Pennsylvania Canal to the west, and by the Allegheny Portage Railroad to the east. When the Pennsylvania Railroad opened in the 1850s, Johnstown was poised to become an important commercial and industrial center.

The Cambria Iron Company. By the 1880s Johnstown was an important steelmaking city. The Cambria Iron Company attracted thousands of workers to its mills and mines along Johnstown's rivers. The floodplains and surrounding hillsides were the new home of immigrants from many European countries. Johnstown was the commercial and civic heart of the region, and the center of an extensive network of coal and ore mines, steel mills, coke ovens, limestone quarries, and railroads.

Gotta See It! PRR Sites

Railroaders Memorial Museum. The Railroaders Memorial Museum is located within the original yard and shop complex of the Pennsylvania Railroad in Altoona. It tells the story of the people who worked on the railroad and has an interesting collection of locomotives, cars, and other railroad artifacts. A new and exciting collection of exhibits, focused on the occupational folklife and everyday work of the railroaders is being installed in the former PRR Master Mechanic Shop throughout 1997.

Horseshoe Curve National Historic Landmark. A modern visitor center at the Curve tells the story of the conquering of the Allegheny Ridge by the PRR. A funicular railway transports visitors to track level where the view is great and train watching is fun.

Gallitzin Tunnel Park. At the summit of the Allegheny Ridge, at the west end of the Gallitzin Tunnels, visitors can get a view of trains roaring in and out of the recently enlarged tunnel. A restored caboose and knowledgeable staff combine for a wonderful railroading experience.

Cresson Train Viewing Platform. Located right along the Mainline in Cresson, this platform provides a great view of the trains.

Iron and Steel

A World of Iron. Iron was a ubiquitous part of the American scene in the early 1800s – it was everywhere! From roof to cellar, a house was as much the product of the ironworker as it was the housewright or mason. Doors swung open on iron hinges, and iron locks and latches kept them closed. "Ten-plate" stoves, so named because they were made of ten flat plates of iron, warmed rooms. In the kitchen, the fireplace hearth was littered with the artifacts of cooking – iron pots, skillets, teapots, Dutch ovens. These hung from iron rods, bars, and chains over the cooking fire. Iron utensils – ladles, spoons, forks, and knives – hung on iron hooks near the hearth, easily within reach of the busy cook. And just think of the hundreds, even thousands, of nails, tacks, brads, and staples that held that house and its furnishings together!

Outside the house, iron gates and fences controlled access to yards and fields. An iron trellis or other fancy work decorated gardens and yards. Iron railings, weathervanes, and roof embellishments, often very ornate, announced that this was the home of a well-to-do family.

In the barns and outbuildings, hammers, scythes, saws, axes, wrenches, and dozens of other tools were put to hard work. Draft animals, in their iron shoes, pulled iron-wheeled implements across the fields. At the local mill, wooden waterwheels reinforced by iron rods and sheets, moved iron sawblades by turning iron gears on iron bearings. Likewise, the grain miller used his waterwheel and an assortment of iron gears, cranes, hooks, chains, and screws to grind grain and move it around the mill. Iron also provided jobs for an army of blacksmiths, forgemen, and foundryworkers.

The Geography of Ironmaking. The production of iron required a complex of interrelated chemical processes. It was dependent on the availability of four ingredients: iron ore, limestone, charcoal, and oxygen. In the early 19th century, with land transportation limited to horse-drawn carts and wagons, it was essential that these ingredients be located near each other. The hills and valleys on both sides of the Allegheny Ridge had great quantities of all of these. By the second half of the 19th century, the expansion of the railroad network along the Ridge made the expansion of the iron industry possible, and set the stage for the production of steel.

The network of secondary roads that we travel today can be traced back to the 19th century iron industry. The delivery of iron ore, limestone, and charcoal to the furnace (the oxygen was already there!) required a system of wagon roads that radiated from the furnace to the mines, quarries, and forests. The location of the furnace was usually determined by access to transportation for the finished product, so furnaces were often located near turnpikes, then the canal, and later, the railroad. The furnace also needed a reliable source of running water to turn waterwheels to power its blast machinery.

The Pyramids of the Ridge. Most of the *iron furnaces* along the Ridge were hollow stone pyramids with arches on two or three of the sides. The furnace, or *stack,* was made of cut sandstone, a common building material of the Ridge. The *in wall* or *lining* had to be of a material that could withstand the intense heat without deteriorating. *Firebrick,* a special brick made of silica sand rather than the typical clay used for red bricks and pots, was the preferred material for the lining. Firebricks were also a product of the Ridge – they were made of ganister, a hard rock common to the mountains east of the Ridge in Blair and Bedford counties. Between the lining and the outer stone wall of the furnace was an air space that allowed room for the lining to shrink and swell as the temperature changed.

The opening at the top of the furnace was known as the *throat* or *trunnel head.* It was through this opening that the furnace was filled, or charged. Iron ore, charcoal, and limestone were dumped into the throat by the fillers who worked on the charging bridge. The charging bridge was a wooden and stone structure that connected the throat of the furnace to a nearby hillside where the raw materials were stored and prepared.

From the narrow trunnel head, the interior of the furnace widened, like an upside-down funnel. This area, where the smelting occurred, was called the *bosh.* Below the bosh, the interior narrowed again at the bottom of the furnace. Here in the hearth, the molten iron and slag were collected and the blast of air entered the furnace through special cone-shaped iron nozzles called *tuyeres.* Stones around the hearth kept the molten iron and slag in place until tapped by the founder. Slag, floating atop the molten iron, was drawn off and discarded before the iron was tapped.

When ready, the iron was drained from the hearth into molds pressed into a bed of sand beside the furnace. The *pig bed* consisted of a series of long, oblong depressions, known as *sows,* connected to smaller depressions, known as *pigs.* This arrangement resembled a litter of piglets nursing on a sow, so the iron made by this process came to be known as pig iron. The molten iron flowed from one depression to the next, much like water flows from one compartment to the next when filling an ice cube tray.

The charcoal-fueled iron furnaces near the Ridge were generally between 20 and 40 feet high. The throat diameter ranged from about 3 to 8 feet, and the bosh diameter was as narrow as 8 to as wide as 15 feet. Later furnaces, fueled with coal or coke, were almost twice the size of the charcoal furnaces.

Coal from Trees? Charcoal, or simply "coal" as it was known to the 19th-century ironworker (the mineral coal was referred to as *stone coal* until the 1880s) was the first fuel used to smelt iron along the Ridge. Charcoal does not occur naturally — it is produced by burning wood in a reducing atmosphere, using as little oxygen as possible. Wood for charcoal was cut and corded during fall and winter. This was the time of year when local farmers were not planting and harvesting, and many found jobs cutting wood for the furnaces. The best time for charring wood was May through October, when, as one historian noted "the air is bland, the roads good, and the furnace yard dry — considerations of great importance."[1]

Charcoal-makers, or *colliers,* produced charcoal by carefully stacking the cut wood vertically around a center post. When all the wood was stacked, the center post was removed, creating an opening that helped draw air through the stack when it was lit. The stack was covered with a few inches of soil, leaving the center hole and a few small holes around the base of the stack open. The pile was lit. Once lit, the collier maintained a round-the-clock vigil, stomping out flames. The idea was to apply low steady heat to the pile, using as little air as possible. If the pile drew too much air, the wood would combust, producing bright flames and reducing the wood to ash, not charcoal.

Colliers were usually paid by the amount of charcoal they produced, ranging from $1.12 to $1.25 for each 100 bushels of charcoal. It was the responsibility of the furnace operator to insure that enough teamsters were available to haul the wood to the collier and the charcoal to the furnace. Each charcoal furnace along the Ridge produced between 40 and 50 tons of iron each week. It has been estimated that it took about 1.5 to 2.5 acres of woods (two to three tons of charcoal), cut and coaled, to produce one ton of pig iron. Twenty years later, that same tract could be cut again.

During the second half of the 19th century, most iron furnaces along the Ridge were modified to burn "stone coal" or coke rather than charcoal. Coal was less expensive than charcoal because it was concentrated at just a few locations; charcoal, or more precisely, the trees from which it was made, were scattered across the landscape.

Coal, when converted to coke, was an even more efficient fuel. Coke is produced by burning coal in a reducing atmosphere — coke is to coal what charcoal is to wood. As noted, it has been estimated that one ton of pig iron required two to three tons of charcoal; a ton of pig iron could be produced with only 1.7 tons of coke. Charcoal was also much bulkier than coke — a ton of charcoal occupied 2.6 times more space than a ton of coke. This meant that more wagons and teams were needed to move charcoal, and larger spaces were needed to store it. By 1890, one ton of charcoal cost four times as much as a ton of coke.

Ore what? In the 19th century, at least eight different iron ores were recognized by the local ironmasters. Each ore had different properties, and the furnace managers knew exactly what combination of ores they needed to make each product. Some of these ores were found in scattered locations, or were too difficult to mine because they were mixed with other minerals. Some of the most productive ores were the *wash ores,* so called because they were found in loose sand, mingled with clay and stones. To separate the ore from the sand, clay, and stones, the ores were thoroughly washed by placing them in a long, shallow trough. A wooden shaft fitted with iron paddles revolved in the shaft, pushing the ore and other material forward while it was agitated. Water flowed through the trough and carried away the finer, lighter particles, leaving the ore. Sometimes, instead of a trough, a revolving wooden cylinder was used. The sand and ore were thrown into the spinning cylinder, water was poured through it, and the sand and clay particles washed out through narrow spaces between the boards in the wall of the cylinder.

Limestone. Limestone was needed to make iron. It was used as a *flux,* a material which helped the iron to separate from the rock, charcoal, and other impurities. Limestone is one of the most common materials in the hills near the Ridge. It was (and is still!) quarried extensively around Morrisons Cove, in Blair and Bedford counties.

The limestone was extracted by two methods: open pit quarrying and open shelf quarrying. An open pit quarry was the excavation of a deep hole which must be drained constantly as it is worked. After cutting, the stone must be lifted from the pit. Open shelf quarrying was generally less expensive and simpler to execute because the floor of the quarry was at ground level. The limestone was recovered by cutting or blasting it off the face of an exposed outcrop. It fell to the floor, and was loaded onto wagons and hauled to the furnace.

The limestone needed little preparation for the furnace. It was usually crushed or broken into small pieces so it could be handled more easily by the fillers. Crushing also helped it to react more efficiently with the ore and charcoal in the furnace.

Refinements. Pig iron was used to make a variety of cast iron objects right at the furnace. The pots, pans, and other items produced on the casting floor were used in many kitchens along the Ridge. Pig iron contains much of the carbon released during the combustion of the charcoal in the furnace. The iron fibers are short and brittle. The carbon and short fibers weaken the iron, rendering it unsuitable for uses where high impact or tensile strengths are required, such as in the making of tools, farm implements, rails, and parts for steam engines. It was at the foundry and forge that the brittle pig iron was transformed into the tough wrought iron that the mills and railroads needed.

At the forge, the pig was carefully reheated until it became soft and pasty. The *finer* worked this mass of iron into a ball using a long iron bar to raise and turn it in the hearth of the forge, much like a baker pulls and folds bread dough. During this process, the carbon is brought to the surface of the *bloom.* When it has been thoroughly heated, the bloom is moved to an anvil where it is pounded into a rectangular block, or *billet.* The hammering removes the carbon and lengthens and aligns the iron fibers.

By the second half of the 19th century, most pig iron was refined in a *puddling furnace.* Unlike the forge, where the iron and the fuel (charcoal, coal, or coke) were combined directly with the pig iron, the fuel in the puddling furnace was contained and burned in a firebox adjacent to, but separate from, the compartment that held the pig iron. Like the finer at the forge, the puddler heated the iron to a semi-molten state, then delivered it, white hot, to the hammer where it was pounded into a billet.

On a Roll. During the refining process, pig iron was converted from cast iron (made in molds) to wrought iron (hammered). The billets were delivered to the mill, where they were reheated, then drawn into wire or tubes, flattened into sheets, or rolled into a variety of shapes and lengths. At the rolling mill, the billet was heated until it softened, then passed quickly through a roll train. A *roll train* consisted of two or three pairs ("two-high" or "three-high") of rollers. Each roller was a grooved, horizontal shaft and they were mounted over each other so that they could easily roll as the billet was forced into the grooves. A crew of men stood on each side of the roll train. One crew, using long tongs, picked up the hot billet and fed it into the first groove on the roll train. The other crew caught the billet as it came through the groove and fed it into the next groove. The crews passed the billet back and forth through the roll train until the desired shape and length were obtained. As the billet was passed through successively smaller grooves, it became thinner and longer. To reduce a six-inch wide billet to a one-inch wide rod, it was passed first through a six-inch groove, then a 4 2/5 inch groove, then a 3 1/5 inch groove, then 2 2/5, then 1 4/5, and finally, a 1 inch groove. By changing the sizes and shapes of the grooves, billets could be made into sheets, bars, rods, girders, or rails.

Iron in PA. The iron industry began in Pennsylvania in 1716 when Thomas Rutter built the first furnace near Pottstown, in present-day Berks County. The industry moved steadily westward, reaching the Ridge area by 1785, when Bedford Furnace and a forge were built near Orbisonia, about 50 miles east of the Ridge.

Iron along the Ridge. During the first decade of the 19th century, furnaces and forges were built on both sides of the Ridge. As early as 1805, a forge was built on the Little Juniata River near Tyrone to refine the pig iron from Huntingdon Furnace. Other furnaces and forges soon followed, including Alleghany Furnace in 1811, Springfield Furnace in 1815, and Rebecca Furnace in 1817. Mount Etna Furnace was *blown in* in 1809 and *blown out* in 1877. In 1849, this furnace produced 1,000 tons of pig iron and employed 100 men. Furnace, forges, foundries, and manufacturers of iron tools flourished in the 19th century along the eastern slope of the Ridge.

On the western side of the Ridge, John Holliday built a forge on the Stonycreek River in 1810. George S. King came to Johnstown in 1833 from Mercersburg, Pennsylvania to take advantage of the business opportunities offered by the new canal system. Envisioning a local iron industry, King searched for and discovered large quantities of iron ore near Johnstown in 1839. He built his first iron furnace on Laurel Run, in Cambria County, in 1842. This furnace, the Cambria, was so successful, that King built four more furnaces within the next five years, and other would-be ironmasters followed. Other early furnaces were Mill Creek Furnace (1845), Benscreek Furnace in Upper Yoder (1846), Eliza Furnace in Vintondale (1846), Mount Vernon Furnace (1846), and Ashland Furnace near Ashville (1847).

These early furnaces were similarly constructed and each produced about 1,000 tons of pig iron annually. They operated during the summer and employed 80 to 90 men. During the winter, the stacks were relined. Most of the furnaces were cold blast, that is, the air was not heated before it was blown into the stack. But the Benscreek and Eliza furnaces were equipped with cast iron pipes that warmed the air before it was blown in. The air was channeled through a radiator-like device mounted near the throat of the furnace. As the air circulated through the pipes of this device, it was heated by the exhaust of the furnace, then channeled down to the blowing machinery where it could be blown in through the tuyeres at the base of the furnace.

19th Century Ironworks East of the Ridge

Name	Years of operation
Alleghany Furnace	1811-1884
Springfield Furnace	1815-1885
Rebecca Furnace	1817-1882
Bald Eagle Furnace	1824-1865
Antes Forge	1828-1855
Allegheny Forge	1830-1855
Mary Ann Forge	1830-1872
Elizabeth Furnace	1832-1834
Sarah Furnace	1832-1882
Colcesser Axe & Pick Manufactory	1832-1915
Portage Iron Works	1833-1904
Frankstown Furnace	1836-1885
Martha Furnace	1838-1890
Duncansville Foundry	1842-1861
Bennington Furnace	1845-1884
Blair Furnace	1846-1870
Chimney Rock No. 2 Furnace	1855-1885
Gaysport No. 1 Furnace	1856-1885
Hollidaysburg Iron and Nail Co.	1860-1905
Rodman Furnaces 1 and 2	1862-1885
Eleanor Iron Company	1869-1905

The Start of the Cambria Iron Company. When construction of the Pennsylvania Railroad began in 1852, George King saw a new market opening. He was convinced that his business would be more profitable if he switched from the production and sale of pig iron to the production of rails. He would continue to make pig iron, but his company would also refine it and roll the rails. To do this, he needed to raise capital, since he now needed to build new furnaces, a refining operation, and a rolling mill. The operation attracted investors from Boston, New York, and Philadelphia, but most of these deals fell through. Eventually, King and his business partners secured a charter from the Pennsylvania Assembly in 1853 for the Cambria Iron Company. Construction began almost immediately on the rolling mill, four hot-blast coke furnaces, refining furnaces, and other buildings in Johnstown, on the north bank of the Conemaugh River, near the new railroad. Just one year later, the new mill produced the first 30-foot long iron T-rails for the railroad.

Financial problems continued to plague the Cambria Iron Company. King resigned in 1853 when control of the company passed to a group of investors from Philadelphia. Foundry prices dropped sharply in 1854, and continued to decline until the start of the Civil War in 1861. In 1855, just before it was sold at sheriff's sale for non-payment of taxes, a five-year lease was arranged with Wood, Morrell and Company.

A New Way to Make Rails. Wood, Morrell and Company brought new ideas and innovations that not only brought success to the Cambria Iron Company, but to the iron and steel industry. Foreman John Fritz improved the rolling mill by using three-high instead of two-high roll trains. His invention was patented in 1858. This mill produced consistently perfect T-rails much more efficiently than the two-high mill. The company's rails were widely considered to be the best because of their superior hardness, overall quality, and resistance to breaking. Much of the quality was due to the nature of the local iron ores and the excellence of Fritz's mill. By 1856, under Daniel Morrell, the new superintendent, 1,500 men were employed at the Cambria Iron Company; by 1861, when the lease expired, Wood, Morrell and Company were taken in as partners in the Cambria Iron Company.

Iron to Steel. The iron industry was forever changed with the invention of the Bessemer Process in 1857. This process converted pig iron to high-grade steel by forcing a cold blast of air through the molten metal, reducing the carbon impurities. Steel is an iron-based alloy that contains less than one percent carbon. Wrought iron, even after refining, typically contains three to five percent carbon and one to three percent silica. The amount of carbon with the iron is the key factor that effects the properties of the material. Steel could be forged or drawn more successfully than wrought iron, and was harder and less brittle.

William Kelly, of Kentucky, and Henry Bessemer, of England, working independently, devised the process for making steel at approximately the same time. Kelly and Bessemer patented their processes in their respective countries. The financial Panic of 1857 bankrupted the Kentucky mill where Kelly was working, and he moved to Johnstown where he continued his experiments for the Cambria Iron Company. Daniel Morrell obtained the rights to Kelly's patent and to Bessemer's patent, through Alexander Holley of Troy, New York.

The Cambria Iron Company rolled the first steel rails in the United States in 1867. They completed construction of their Bessemer works in 1869, and by July 10, 1871 were fully operable. They were so successful that the original shop was almost immediately expanded, using four ten-ton vessels. The Cambria Iron Company was one of America's largest steel makers. During the month of March in 1876, the company produced 6,051 tons of steel!

Improvements to the Bessemer Process came quickly. The Open Hearth Process used an open flame to remove carbon impurities rather than a blast of air. It took longer than the Bessemer Process, but it produced higher quality steel. It was first used in Johnstown in 1879, and by 1907, the company was using four 20-ton and fifteen 50-ton open hearth furnaces. In 1907, Cambria Steel Company employed 16,500 men and its stock was valued at $45 million.

The Name Game. The Cambria Iron Company became the Cambria Steel Company in 1898. Midvale Steel and Ordnance Company bought 97 percent of Cambria Steel's stock in 1916, and in 1923 Midvale, including Cambria Steel, was absorbed into Bethlehem Steel.

Steel Diversity. The Cambria Iron Company founded or acquired subsidiaries that produced other steel products. Joseph Gautier moved his plant from Jersey City, New Jersey to Johnstown in 1878. The Gautier Works manufactured wire (including barbed wire), steel carriage springs, teeth for hay rakes, parts for mowers, and other tools.

In 1883, A. J. Moxham and his associates formed the Johnstown Steel Street Railway Company in Woodvale. This company produced rails for streetcars and trolleys. It was quite successful, despite its destruction by the 1889 Johnstown Flood. Following the flood, it immediately rebuilt in Moxham. It was renamed the Lorrain Steel Company in 1898, and became a subsidiary of the Federal Steel Company, and then the U.S. Steel Corporation by 1901. The works was once again badly damaged by flood in 1977. U. S. Steel bailed out, but the plant soon reopened under local ownership and continued to produce steel.

By 1922, Johnstown's steel mills were producing steel rails, beams, girders, roof trusses, railroad cars and axles, street cars, mine cars, machine bolts, nuts, rivets, piston rods, railroad car wheels, crank pins, steel for agricultural implements, wire, wire rods, bars, and a host of other tools and parts.

Steel for Everyone! Johnstown was a world leader in steel production in the late 19th and early 20th centuries. The industry boomed during World War I, peaking in 1917 when Cambria Steel produced 1,567,703 tons of steel ingots. Steel car shops opened in 1901, a new wire plant opened in Morrellville in 1911, and the steel car-wheel shop opened in Franklin Borough in 1917.

The city grew with the steel industry. At the time of the flood in 1889, the population of Johnstown was approximately 10,000. Just about 30 years later, by the 1920 U.S. Census, Johnstown was the ninth largest city in Pennsylvania, with a population of 67,327.

Down, But Not Out. The steel industry continued to boom through the first half of the 20th century. World War II and the post-war building and car-making boom brought prosperity. By the late 1950s, Johnstown's mills employed more than 13,000 workers. The changing national and world economy has devastated the American steel industry. The availability of cheaper foreign steel has cut deeply into the market. The railroad industry, traditionally one of the biggest customers for steel, has also stagnated, reducing its demand for steel products. Products previously made of steel are now made of plastic and other materials. Environmental awareness and stricter pollution laws have lead to changes throughout the manufacturing sector, and steel production has been curtailed as more environmentally-sound methods, using other raw materials, have grown.

Just as the city of Johnstown grew with the steel industry, is has also declined with it. Bethlehem Steel closed in 1992. Most of the coal mines have closed. The population continues to drop. But the story of steel is at the center of a rebirth in Johnstown based on heritage tourism. The stories of the people who came to Johnstown to make steel are compelling, and people from across the nation and around the world want to know about it, and they're coming here to learn it. The city is filled with places where visitors can experience that story, whether it's a tour through a mill or coal mine, a ride on the Johnstown Incline, a walk through a historic neighborhood, a stop at a museum, or an ethnic dinner in a church basement. It's the next chapter in the story of iron and steel in Johnstown.

Gotta See It! Iron and Steel Sites

Baker Mansion/Allegheny Furnace. Baker Mansion was the home of ironmaster Elias Baker and his family from the time of its construction in the 1840s until 1914. It has been the home of the Blair County Historical Society since 1922; call them to arrange for a tour. Baker's furnace is located about a block away, in the backyard of the Altoona Women's Club (private property). The Clubhouse was the company store. Other ironmasters houses and furnaces are located throughout Blair, Cambria, Centre, Indiana, and Huntingdon counties — contact a local historical society to learn more.

Etna Furnace (Lower Trail). Etna Furnace is owned by the Blair County Historical Society. It is located just off the Lower Trail, near Williamsburg. Near the furnace are many other buildings associated with this iron plantation.

Royer Mansion. This ironmaster's house is also owned by the Blair County Historical Society and is being carefully restored. It is located on Route 866, south of Williamsburg and north of Martinsburg. The ruins of Springfield Furnace are located nearby.

Eliza Furnace (Dilltown Trail). This furnace, near the Cambria and Indiana county lines in Vintondale, is one of the few that still has the iron pipes near the trunnel that heated the blast of air during ironmaking. Its along the Dilltown Trail, a Rails-to-Trails project.

Williamsburg Historic District. Throughout the town of Williamsburg, in Blair County, you can see the products of the nearby iron furnaces. Many 19th century houses have ornate iron porch railings and posts; the Eagles Club is particularly impressive.

Canoe Creek State Park. This park in Blair County includes lime kilns and limestone quarries. Models and exhibits in the Visitor Center explain how the lime kilns operated, and how they are related to the steel industry.

Greenwood Furnace. This State Park is located in Huntingdon County and has a good collection of structures, documents, and artifacts related to the iron furnaces there.

Cambria Iron Company National Historic Landmark. This important complex of buildings in Johnstown can be viewed from the observation deck of the Incline, or by looking across the Conemaugh River from Cambria City.

Coal and Coke

The Allegheny Ridge is located in the bituminous coal region, an area that includes much of western Pennsylvania west of the Ridge. In the late 19th and early 20th centuries, the western Pennsylvania coalfields produced about one-fourth of the nation's coal. In 1897, Pennsylvania miners produced 55 million of the 147 million tons of coal mined that year, or about one-third of the national total. More than any other natural resource, coal is responsible for the transformation of the region's 18th century farmers into 19th century industrial workers.

The Pennsylvania Tropics. The coal deposits are older than the 250-million-year-old Allegheny Ridge. They are the remains of a lush, tropical forest that once covered the region. Tropical? Pennsylvania? You bet! In the 1960s, after years of speculation, geologists finally assembled the concept of plate tectonics. They had suspected that the continents had been drifting around on the surface of the earth, colliding and breaking apart (anyone who's ever looked thoughtfully at a map of the opposing coastlines of South America and Africa has probably reached this same conclusion), but it wasn't until the 1960s that they understood what made the continents move. Decades of observations of volcanic and earthquake activity, on land and under the oceans, finally led them to a discovery that, basically, the semi-liquid material below the earth's crust flows in currents as it heats up and cools off, and the continents float along on these currents of molten rock. They don't move very fast, but they do move.

When Pennsylvania was covered by the lush tropical forest, it was actually located near the equator, a region of the earth where there are still lush tropical forests. Pennsylvania was also relatively flat and swampy at that time. As the forest went through its cycles of growth and decay, vast quantities of organic material (that is, things with carbon in them) fell into the swampy soils. Through time, heat and pressure transformed this material into peat; with even more time, more heat, and more pressure, the peat became coal. And while all this was happening, the ancestral continent of North America moved steadily northward, away from the equator, on a collision course with the ancestral continent of Africa.

Eventually, the continents collided. Ancient layers of rock buckled and wrinkled, like the fender of a car that bangs into a tree. The force of this continental collision rippled the layers of rock from east to west. The Allegheny Ridge is actually the westernmost "wrinkle." So, east of the Ridge are a series of ridges and valleys where the underlying rock layers have been pushed up, shoved down, bent and folded. West of the Ridge, the rock layers are still relatively flat-lying. Almost all of the bituminous coal mined in the United States lies in the flat rock layers west of the Ridge. There is some bituminous coal east of the Ridge, notably, the East Broad Top coalfield of Huntingdon, Bedford, and Fulton counties, but this is an exception, a geological erratic.

Bituminous or Anthracite? The coal along the Ridge is *bituminous*, or "soft" coal. *Anthracite*, or "hard" coal, is found in northeastern Pennsylvania, in the vicinity of Scranton, Wilkes-Barre, and Pottsville. Anthracite is almost pure carbon (86 to 98 percent); it is sometimes called smokeless coal because it has so few volatile compounds, other than moisture, that are driven off as the coal is burned. Bituminous has a carbon content varying from 45 to 86 percent. Anthracite has a heat value of nearly 15,000 BTUs-per-pound[2]; the heat value of bituminous ranges from 10,500 to 15,500 BTUs-per-pound, but the heat value of bituminous can be increased by reducing it to coke. In the coking process, most of the volatiles, moisture, and other impurities were removed, leaving almost pure carbon.

When coal is burned, it releases sulfur into the air. As we know now, the sulfur combines with precipitation to make acid rain, a serious environmental problem. The burning of coal also produces ash. Ash is composed of the *inorganic* (that is, non-carbon) materials in coal that do not burn. Good quality coal produces little ash. The bituminous coal of western Pennsylvania has a lower ash content than anthracite, and a sulfur content of 1 percent or less.

Where Did All That Coal Go? Throughout the first half of the 19th century, the demand for coal grew steadily. The establishment of glass factories, iron furnaces, woolen mills, and other steam-powered industries consumed tons of coal every day. By the second half of the 19th century, the railroad became a major coal consumer and coal shipper. As forests diminished around the growing cities of the East, coal replaced wood as the primary home-heating fuel.

Going Down, Down, Down, Down. Coal is underground. Its depth may vary from a few dozen feet to hundreds of yards. It sometimes outcrops in the sides of hills. For most of the 19th and into the early 20th centuries, coal miners worked underground, in a dark, damp workplace. The threat of being crushed or trapped by the collapse of a tunnel, or of being blown up by an explosion of combustible gases was very real for the men who mined coal.

Underground mines were entered either by cutting back into an *outcrop* of coal, visible in the side of a hill, or by digging down, either at an angle or vertically, to the buried seam and then following it horizontally. Miners, equipment, and coal were hauled through the mines by animal-, steam-, or electrically-powered hoists and cars. Pumps worked constantly to remove water from the deepest mines, and ventilation shafts and fans circulated fresh air into the mines. Local woodcutters and sawmills were kept busy providing the miles of timber needed to shore up the walls and roofs of the mines. Iron and steel producers manufactured miner's tools, and parts for the cars and machinery that moved the coal out of the mines and to the railroads.

Underground Work. When the coal mines along the Ridge were first opened in the early 19th century, mining was done by hand by skilled workers. Miners, lying on their backs or sides on the damp mine floor, used picks to dig out the rock beneath a small section of the coal seam. When they finished this *undercutting,* they dug vertical cuts, perpendicular to the undercut, down the face of the seam. They drove wedges into these vertical cuts until the block of coal cracked off and fell into the undercut. The wedges were eventually replaced by explosives. Instead of a long cut made with his pick, the miner used a drill to bore a hole into the coal. The explosive was pushed into the hole and ignited by a long fuse. The resulting explosion loosened the coal and dropped it onto the floor of the mine.

Once the coal was loosened, it was shoveled, by hand, into wooden, and later, steel cars. The cars were pulled to the surface by mules or horses. In deep mines, steam engines powered hoists, elevators, and other machinery to pull the heavy coal out of the mines, somewhat similar to the stationary steam engines used to haul canal boats up and down the planes of the old Allegheny Portage Railroad, or, the electric motor of the Johnstown Inclined Plane.

Above ground, at the *tipple,* the coal was sorted by size and the stones and other debris were picked out. From the tipple, it was loaded onto wagons or railcars and delivered to the customer, or taken to the cokeworks .

Coke — The Real Thing. Coke is made by heating coal in the absence of oxygen, or, as the chemists would call it, in a *reducing atmosphere.* Coke is almost pure carbon. It has a greater heat value than coal. By the late 19th century, coke was the preferred fuel of iron and steel makers.

The switch to coke from charcoal for the blast furnaces was due, at least in part, to the voracious appetites of those furnaces for charcoal. Each year, a typical rural furnace consumed about 240 acres of forest — that's about 5,000 to 6,000 cords of wood. It took twenty years for a usable forest to grow back on that 240 acres, so each year the woodcutters and colliers were forced to move farther and farther from the furnace. The teamsters had to haul the charcoal farther, and, eventually, the colliers working for one furnace met the colliers working for the next furnace — they ran out of trees to cut! If you'd toured the Ridge a little more than a hundred years ago, you would not have seen many trees. Hard to believe when you look at all the trees growing on the Ridge today!

As wood for charcoal disappeared, the ironmasters and steelmakers had to find a new fuel. Some furnaces, like the Ashland Furnace, near Ashville in Cambria County, unsuccessfully experimented with mixtures of cordwood and stone coal for fuel. Other furnaces closed. Large companies, like the Cambria Iron Company of Johnstown, invested in the development of cokeworks.

The coals of the Ridge had different qualities — some were easy to mine, some burned well to heat homes, some worked well for steam engines and locomotives. But coal from one seam, the Pittsburgh seam, made excellent coke. The Pittsburgh seam was quite extensive, but the biggest deposit was in Fayette and Westmoreland counties, and it was there that tens of thousands of coke ovens were built. A small segment of this seam stretched into Cambria County, even to the eastern slope of the Ridge, near Gallitzin and the Horseshoe Curve.

Coke from a Beehive. Along the Ridge, coke was produced in arched, brick ovens that resembled the straw hives in which 18th and 19th farmers housed bees. Long rows of these beehive ovens were built along hillsides, or back-to-back. Like the charcoal iron furnaces, they were filled from the top. In practice, the beehive oven was an adaptation of the earthen mound the collier had constructed to make charcoal — the earth covering he placed over the woodpile served the same purpose as the arched brick "mound" — it kept the air out.

A typical beehive oven varied in height from 5 to 10 feet and had a floor between 10 and 13 feet in diameter. The opening at the top, called a *trunnel* (a word borrowed from the iron industry) was about a foot wide. Like the iron furnace, the oven was filled, or *charged*, from the top, through the trunnel. Doors around the base of the oven were bricked-up during coking, then opened to remove the coke.

Charge, Level, Burn. Coal was delivered to the ovens by *lorries*, small cars that ran on rails on top of the ovens. The lorries were shaped and hinged so that they could easily be dumped or unloaded. The charger, who operated the lorry, filled each oven with about 7 tons of coal for a 48-hour burn.

The leveler worked through the doors at the base of the oven to level the coal as it was filled. He used a long, specially designed bar to spread the coal around evenly in the oven. When the oven was filled and leveled, he sealed the door with bricks and mud, leaving a small space to allow just enough air into the oven to ignite the coal. If the oven had been emptied quickly, the hot bricks in the roof of the oven spontaneously ignited the coal. Smoke and flames poured out of the trunnel as the coal burned.

The coal burned from the top down. After about 48 hours, the oven burned out. The water boy removed the bricks in the door and sprinkled the coke with water to cool it down so it could be unloaded. The scraper pulled the coke from the oven and loaded it into railcars.

Movin' On. Like the transportation and steel industries, new technology brought major changes to the coke industry. Near the end of the 19th century, a new oven, the *by-product oven,* was developed in Europe. It produced coke much more efficiently than the beehive ovens. But the by-product ovens also collected the gases that escaped into the atmosphere through the trunnel of the beehive ovens. Many of these gases, or by-products, could be refined into oils, dyes, fertilizers, explosives, tar, and pitch, all commercially viable products that could be sold directly to consumers, or to the new chemical industry. Some of the gases were reused right at the oven.

The switch to by-product ovens was gradual in western Pennsylvania. It is estimated that there were more than 20,000 beehive ovens in the region, representing an investment of millions of dollars. It was also more expensive to build by-product ovens — $300 for a beehive, compared to $1,600 to $2,000 for a by-product. However, in 1894, the Cambria Iron Company built 60 by-product ovens in Johnstown.

In the early decades of the 20th century, the amount of coke from by-product ovens steadily increased, surpassing the production of the beehive ovens in 1924. The shift changed the geography of coking. The beehive ovens were located near the source of the coal, and the coke was transported to the market. By-product ovens were located near the markets for the coke and the by-products, that is, they were located near the steel mills and chemical plants. Except for the Cambria Iron Company in Johnstown, most of these markets were away from the Allegheny Ridge. Coal was still mined, but it was shipped out of the region to be used at the by-product ovens, and to other locations. By the 1920s, almost all of the coke ovens had been closed, and by the 1930s, so had most of the mines along the Pittsburgh seam.

Squeeze Play. After 1880, private investors realized that they could make lots of money in the coalfields of western Pennsylvania. The market for coal grew rapidly, and, as the railroads expanded both into the coalfields and into the markets, coal could be shipped efficiently and profitably. Men like Henry Clay (H. C.) Frick and Charles Berwind saw this opportunity, and seized it.

However, unlike ironmaking or railroading, almost anybody with access to a coal seam, a few tools, and a wagon, could get into the coal business and make a tidy profit. As the large corporations grew, they gained control not only of the mines but also of some of the railroads. They squeezed the small coal operators out of the business. A railroad superintendent could, for example, limit the number of coal cars available to the operator, thus limiting his ability to get coal to his customers. If this happened regularly, he would lose customers, since they couldn't depend on the reliable delivery of coal from those mines.

The Berwind-White Coal Mining Company. Philadelphia-born Charles Berwind started the company that would become the *Berwind-White Coal Mining Company* in 1874. The company opened its first mine that year near Houtzdale, in Clearfield County. The company became known for the high-quality and on-time delivery of Eureka Coal, a coal from the Ridge that was especially well suited for fueling steam boilers. Berwind-White sold coal to the New York City subway system and to many transatlantic steamship companies. Eventually, the Berwind-White Company bought its own steamship line, shipping coal to many locations along the East Coast, and across the Atlantic, to France.

The town of Windber near the Allegheny Ridge was the company's regional headquarters. The company created Windber as the model company town, with housing for its workers, a company store, and a diverse business district. Like employees of many coal companies, miners and their families were required to live in houses they rented from the company. Miners spent their pay on groceries and products in the company store. The company built towns near all its mines. In West Virginia, these small coal towns were known as *camps*; in western Pennsylvania, they were known as *patchtowns*, or simply, *patches.*

The Company Town. At the outset, the idea of a company town, whether for coal miners, ironworkers, steelworkers, or railroaders, was not such a bad idea. In the days before the on-demand personal transportation provided by the automobile in everyone's driveway, people walked. They walked to work. They walked to the store. They walked to church and school (you have undoubtedly heard some of *those* stories!). If they lived in a larger town, they could use the streetcar. Transportation between towns was by train. To the owner of a company that needed lots of workers, like coal mining, it made sense to locate the miners near the mine, so they could walk to work. Since many mines were far from cities and towns, the companies built stores where its employees could buy the things they needed. Problems with this system soon became apparent.

Many miners were recent immigrants to the United States. The coal companies had mounted a vigorous, and very successful, recruiting campaign that enticed thousands of would-be miners from Italy, Wales, Scotland, Ireland, Sweden, Hungary, Slovenia, Croatia, Russia, and Poland. They didn't speak the language, they didn't know the customs, they weren't sure about how the government worked. They found jobs with the coal company, which gave them a house and relatively steady pay. The coal company saw the money paid out to the miners come back, in the form of rent and store receipts. When cash was short, as often happened in the rural patches, miners were paid in *scrip*, paper money, coupons, or tokens that could only be used in the company store. The miners were trapped — if they complained or quit, they lost not only their jobs, but their homes. They couldn't save money to move because the company scrip could only be used to purchase goods from the company store. The store had a virtual monopoly. Without competition in the patches, it could set its prices as high as it wanted. The miners couldn't afford to leave, and they could barely afford to stay.

The coal companies believed that married men were better workers than unmarried men. To entice married men and their families, the companies offered single-family, or two-family homes, with yards and gardens. The rent usually included water, heat, and electricity, where these were available. Even though these houses were small, usually only four rooms, they were often an improvement over the living conditions the immigrants had left in their homelands. The small number of single men who were hired were housed in tenement-type housing.

The company towns were organized so that the differences between miners and their fellow employees, and between miners and their bosses, were very obvious. The foreman, managers, and owners lived in one part of town, in houses that were substantially different from those of the miners. The finest house in town, usually on a hill overlooking the entire community, was the mine superintendent's mansion. Foreman lived in large brick homes of six to eight rooms. Mechanics and other skilled workers often lived in spacious frame dwellings. The majority of the houses in any patch were simple four-room wooden houses for the laborers.

Often, miners were also separated by ethnicity — Poles here, Italians there, etc. To many miners and their families, it was comforting to be surrounded by others who shared their language and traditions. However, it also led to a certain mistrust between ethnic groups, and sometimes prevented miners from uniting for labor-related causes. The most recent immigrants from eastern and southern Europe were usually given the lowest level of housing, closest to the mine, the source of irritating noise, smoke, and dirt. Descendants of Welsh, Irish, Scots-Irish, whose families had been in America for at least a generation or two, as well as native-born Pennsylvanians, often lived in a separate area in houses that had amenities that were not extended to the eastern and southern Europeans, such as indoor plumbing, a tub, a separate kitchen, and window screens.

Unionize! One of the most compelling stories of the people who mined coal along the Ridge is their persistent struggle with the companies to control their own lives. Coal mining was hard, dangerous work. Miners worked ten or twelve hours a day, six days a week. They were paid by the amount of coal they produced, not by the amount of time they worked. The company's influence and control extended from the mine to their homes. As conditions worsened for the miners, their frustration grew.

The United Mine Workers of America (UMWA) was founded in 1890 to obtain a safer work environment, fair and equitable pay, and personal autonomy for its members. At the beginning, the union was distrusted by both the miners and the coal companies.

Conflict and Struggle. In the three decades following the founding of the UMWA, the coal industry underwent tremendous changes. Many of the processes that had been done by hand, such as undercutting and loading, were now mechanized. New, larger mines were opened, as the demand for coal rose, and, despite mechanization, more miners were hired. With the new machines, mining was safer, and the average output for a miner working for one day rose from 2.5 to 4 tons. Coal flooded the market, and prices dropped. Companies couldn't pay workers. As prices continued to drop, especially after World War I, the tensions between mine workers and companies rose.

The final decades of the 19th century and the early decades of the 20th century were marked by a long, intense series of conflicts, often violent. Coal operators lowered wages for miners in response to the lessening demand for and falling price of coal. The UMWA reacted by organizing strikes and work stoppages. Companies retaliated by evicting miners and their families from company housing, and by hiring non-union workers, known as *scabs* by the union members. The word scab is still used by strikers in many occupations to describe workers who are hired to do their jobs while they are on strike, whether union or not.

The influential and powerful coal operators often sent the local sheriff, or hired and armed their own security police, to carry out eviction notices and to break up gatherings. Violence was used by both sides. Mine workers sabotaged equipment and assaulted non-union workers; the company police beat up miners. People on both sides died.

Windber, 1906. Even though the Berwind-White Company successfully managed to keep its miners from unionizing, it had its share of labor problems. The company was hit by the same economic conditions that ravaged the rest of the coal industry — falling prices and lessening demand. They adjusted wages accordingly, often to the dismay of the miners. The miners struck for better working conditions in early spring, 1906. The company fired and evicted striking miners, and hired new workers. Frustration grew on both sides, and erupted on April 6, the day after Easter. A gathering of miners became an angry mob as it protested the arrest of several miners. The miners threw stones at the local jail where the miners were imprisoned. Company police fired into the crowd, killing four people, including a 10-year-old boy who died from his wounds several days later. Seventeen others were wounded.

Coal Operations on the Ridge — Cambria County. As early as 1769, the presence of coal was known on a tract of land owned by William Barr, on the Stonycreek River near present-day Moxham. By 1825, it is believed that Matthew and Michael Myers opened a mine about a mile west of the present location of Lilly. Coal from this mine was transported by packhorse over the Ridge to the Juniata Valley, where it was used for blacksmithing. The Lemon family, with the famous tavern at the head of Plane 6 on the Summit Level of the Portage Railroad, were mining coal on the Ridge by 1836, and selling it to the railroad.

Coal mines followed the railroads and iron and steel industries. Charles Murray began mining in Vinco in 1839, William Tiley in Lilly about 1840, and William Rogers opened another mine near Lilly in 1843. The Rhey Furnace Mine opened in 1853; it was located near the location of the railroad station in Johnstown. One of Johnstown's most infamous mines, the Rolling Mill Mine, went into production in 1856 to provide coal for the new rolling mill at the Cambria Iron Company. This mine was located under Westmont, with portals on the slope below the Johnstown Incline.

Coal mines flourished along the Pennsylvania Mainline. The first mine in South Fork was opened between 1867 and 1869. The Aurora Mine opened on the north bank of the Conemaugh River in 1880, the same year that C. A. Hughes began mining near Lilly and Cassandra. The Gallitzin shaft was sunk in 1882; the Sonman Drift Mine opened in 1883, as did a mine at Ehrenfeld. Dunlo and Lloydell opened in 1891, and Nanty Glo and Twin Rocks in 1892. In 1910, J. H. Weaver and B. Davidson Coleman founded the patch town of Colver, (a conjunction of their surnames); the associated mine proved to be one of the county's most successful. In 1911, 3,490 tons of coal per day were removed from this mine; as late as 1954, it was still producing an average 5,400 tons per day. In 1916, Coleman and Weaver opened a shaft at Revloc (Colver spelled backwards) which later became Bethlehem Mine No. 32.

The names of several northern Cambria County coal towns are testaments to the politicians and wealthy industrialists who built them. James A. Beaver, D. H. Hastings, and

J. L. Spangler acquired more than 14,000 acres of coal lands, doing business as the Blubaker Coal Company. Beaver went on to become the governor of Pennsylvania; Spangler was a member of his staff. The mining community of Hastings was established in 1888, and Spangler in 1893. General John Patton founded the town that bears his name in 1892. Thomas Barnes founded Barnesboro in 1893, shortly after acquiring 12,000 acres of coal lands in 1889.

Coal Operations on the Ridge – Somerset County. Local rail lines were expanded, and more remote coal fields were opened, far from the Mainline. In Somerset County, the Keystone Mine opened in 1872; others soon followed, since the valuable coking coal of the Pittsburgh seam extends into this region, near Salisbury and Berlin. The Cambria-Elk Lick Coal Company opened its Shaw Mines, and between 1886 and 1906 built 100 coke ovens. Near Berlin, Thomas Price opened a mine in 1875; by 1899, Althouse Mines and the Pine Hill Coal Company had extensive operations in the region. The Listie Coal Company opened mines in northern Somerset County in 1893. Their coal was considered to be some of the best coal for steam boilers in the United States. In 1894, the Berwind-White Coal Company began acquiring some of the 50,000 acres of coal lands they would eventually own. Their Eureka Mines No. 30 and No. 38 were opened in 1897, and the town of Windber was built. The Somerset Coal Company absorbed many of the smaller coal operations in Somerset County in 1902, consolidating 16 of the 53 mines that were in production in the county that year. Other companies, like the Merchant Coal Company with its mines near Boswell, the Quemahoning Coal Company, and the Ursina Coal Company, operated successful mines in Somerset County during the late 19th and early 20th centuries.

Coal Operations on the Ridge – Blair County. In Blair County, geology limited coal mining to the immediate eastern slope of the Ridge. The earliest mines were located along the Pennsylvania Railroad as it made its way up the Ridge by way of the Horseshoe Curve and Gallitzin Tunnels. Adjacent to the Horseshoe Curve, the Liberty Coal Company and the Glen White Coal Company mined and coked coal. Near Gallitzin, at the top of the Ridge, the Argyle and Bradley mines were opened, and the Bunier and Russet coal companies worked the seams above Altoona, near the Buckhorn. Later, the Pennsylvania Coal and Coke Corporation mined coal and operated coke ovens in Allegheny Township, near Gallitzin.

How much?! By 1907, there were 130 commercial mines in Cambria County, 53 in Somerset County, seven in Blair. In 1918, the peak year of coal production, 60 million tons of coal were produced from the mines within a 40-mile radius of Johnstown. That was one-tenth of all coal produced in the U.S. that year! By 1923, the value of coal produced in Pennsylvania exceeded the value of all the gold, silver, and copper mined in the country that year.

Modern Surface Mining. Coal mining near the Ridge in the late 20th century is a different industry. Few, if any, underground mines are working. Modern coal miners work at *surface mines,* sometimes called *strip mines.* Surface mining is accomplished by removing the layers of rock and soil above a coal seam (the *overburden*), and then blasting and removing the coal. Equipment used at surface mines includes draglines, shovels, bulldozers, front-end loaders, bucket wheel excavators, and trucks. This equipment is enormous, almost too big to comprehend! On some of the really big mines, the trucks can carry more than 200 tons of coal. By comparison, the tri-axle coal trucks we see on roads around the Ridge carry about 15 tons.

Surface mines seriously alter the landscape. Tons of soil and rock are moved before the first ton of coal is removed. This overburden is stockpiled, and when the mine is closed, this material is moved back to restore the landscape as carefully as possible to its former shape. During reclamation, trees and other vegetation are planted.

The Legacy of Coal. Coal provided jobs for thousands of miners along the Ridge; it still provides work for a small army of miners, truck drivers, and other mine workers. Like the transportation, iron, and steel industries, coal mining has also left its mark on the Ridge. Most notable are the patch towns, with their regular rows of similar houses. These houses have long passed out of the ownership of the coal companies, and their private owners have sometimes gone to great lengths to distinguish their homes from the dozens of like homes in their towns.

Not far from each patch is the *bony pile,* the material cleaned from the coal as it was mined. The size of a bony pile, and some along the Ridge are quite impressive, can be a good indication of how long the mine operated. Some of these piles are being removed, or even recycled — it has been found that they often contain material that can be used in cogeneration plants to produce natural gas. Bony piles can be a source of *acid runoff,* a danger to aquatic life in nearby streams, not to mention drinking water supplies.

Acid runoff is similar to *acid mine drainage* (AMD), polluted water that flows from abandoned mines. AMD is caused by the reaction of water with the iron sulfide in pyrite, a common mineral found with the coal of the Ridge. When pyrite is disturbed, as it is during coal mining, it weathers and reacts with water, creating a solution that contains high levels of iron, aluminum, and sulfate. When this solution is exposed to oxygen, (which it is as it leaves an abandoned mine) iron, manganese, aluminum and other metals are deposited in the streambed. This discolors the water and the streambed, giving it its characteristic rusty-red, orange, yellow, and sometimes even white, color. The stream becomes toxic, no longer able to support aquatic plants and animals. It is estimated that there are more than 250 separate sources of AMD on the Stonycreek and Conemaugh rivers alone.

The sulfur from burning coal, and other fossil fuels, has also been identified as a major cause of *acid precipitation.* As the sulfur, a major inorganic component of most coal, is released into the atmosphere as sulfur dioxide, it reacts with moisture, falling back to earth as a mild acid in rain and snow. Acid precipitation can kill plants and animals, as well as hasten the weathering of building materials.

Tons and tons and tons of coal were removed from under the landscape of the Allegheny Ridge, leaving miles and miles, acres and acres of subterranean openings. As water and gravity work on these spaces, collapses occur that can cause buildings, roads and other structures on the ground above them to move. This condition is called *subsidence.*

Perhaps the most insidious legacy of coal is the effect it has had on the people who mined it. Many miners suffer from arthritis, rheumatism, and other problems with bones and muscles caused by long years doing hard work in cool, damp conditions. In the course of a mining career, they inhaled the fine black dust so common to every coal mine. This dust collected in their lungs, making breathing difficult. *Black lung disease,* as it is known, is a serious, disabling problem among retired miners.

Something for Everyone? Decades of record-breaking construction projects and technological innovations in transportation and manufacturing shaped the people of the Ridge into the most experienced industrial workforce in the world. There was plenty of work and plenty of money, and workers from around the world perceived this as plenty of opportunity. They came to the Ridge by the thousands, and soon learned that the work and the money were here, and that they could get a share of it, although those shares were not equal. Some people got very rich; others barely made a living.

Gotta See It — Coal Sites

Seldom Seen Mine. Follow the Path of Progress extension from Cresson to tour this mine, near Patton. Real coal miners talk to you about working in the mines. A good collection of buildings and other structures are also on the site, but the stories, and the chance to talk with people who really mined the coal, are the best reasons to go!

Portage Area Historical Society Museum. Located in the well-preserved PRR station (1926) in Portage, you can see exhibits and view the award-winning documentary, 63 Men Down, the story of the Sonman Mine Explosion in 1940.

Coke Ovens near Horseshoe Curve, Gallitzin, and Cresson. Ask for directions at the caboose at the Gallitzin Tunnels to see the coke ovens near that town. If you follow the Path of Progress west from the Horseshoe Curve, watch carefully on the slope across the stream on the north side of the road, about a ½ mile west of the traffic light/tunnel under the Curve.

Colver, Revloc, and other coal patches. Colver and Revloc are located off Route 422, just west of Ebensburg. If you are observant as you travel around Cambria, Somerset and Indiana counties, and you watch for bony piles, mine structures, and rows of similar houses, you'll have no trouble identifying other coal patches.

Windber Coal Heritage Center. The center is located in the former post office of the Berwind-White Coal Company. Media presentations and archives describe the everyday life of the miner and his family, the evolution of coal mining technology, and the impact of the Berwind-White Company on the town.

Eureka Mine 40 Overlook. From the overlook at Scalp Level, you get a good view of the Berwind-White Coal Company's mine, opened in 1905, as well as a good look at the layout of a coal patch.

AMD sites and streams. You can't miss 'em — just look for the distinctively orange water. If you want more details, contact local soil and conservation offices.

AMD and Art. Contact the Allegheny Heritage Development Corporation in Hollidaysburg for details about this project that is creating landscape art and cleaning up AMD at the same time!

The South Fork Dam. While the Allegheny Portage Railroad was under construction, related canal projects were also in the works. One problem with being along the continental divide is that most streams and rivers are small headwaters, with relatively little water, especially during the typically dry months of late summer and early fall. This was a problem for the canal builders who needed to insure that the canal would have enough water to float the boats from the spring thaw through the travel- ending ice and snow of the next winter. They needed a reservoir where the abundant snow melt and spring rains could be stored for use later in the year. To do this, a large earthen dam was built on the South Fork of the Conemaugh River, west of the Ridge, and high above the city of Johnstown. The dam was the largest of its type ever constructed, and was not completed until 1852, the same year that the railroads put the canal out of business. By the time it was completed, the dam was no longer needed.

The very industries that brought prosperity to the Ridge also inspired a greater appreciation for its natural beauty. During the summer, warm air trapped smoke and soot in the valley cities and towns for days. Those who could afford it looked to the ridgetops, above the smoke and grime, for summer retreats. The green hills surrounding the abandoned South Fork Dam provided just such a retreat, and well-to-do industrialists and businessmen and their families from Pittsburgh formed the South Fork Fishing and Hunting Club. With minimal maintenance and repair, the dam created a reservoir for boating and fishing, and was far enough from town to be quite private. By the late 1880s, the south shore of Lake Conemaugh was lined with a dozen or so very fashionable cottages. Occasionally, someone in Johnstown wondered about the safety of the dam, but most believed and trusted that it would hold, unable to imagine the consequences if it failed.

The dam had been built by the state as part of the Pennsylvania Mainline. The engineers planned that it would store enough water to use in the drought-prone canal basin in Johnstown, as well as the Western Division of the canal. Without it, they were unsure that there would be enough water to float the canal boats. The dam was under construction for 14 years, and was finally completed in 1852. At the time of its construction, the South Fork Dam was the largest earthen dam in the world.

Safeguards. Since this was an earthen dam, it was designed with two important safeguards to prevent water from flowing over its top, or breast. Unlike dams of masonry, or even wood, water could not flow over earthen dams without resulting in damaging erosion, or, in some cases, the complete failure of the dam. At the South Fork Dam, a spillway was cut into the rocky hillside at its northern end. The bed of the spillway was lower than the top of the dam, and allowed water to flow through it when it rose to within a few feet of the breast.

The second safeguard was a masonry culvert, or tunnel, through the bottom of the dam. Inside the culvert, large pipes, or sluices, carried water through the dam. The upstream, or eastern ends of the culvert and pipes were under the lake, near the base of the dam. The downstream, or western end, opened into the natural bed of the stream. Each of the pipes could be opened or closed independently by a valve attached to its eastern end, under the lake. In this way, a controlled amount of water could be drained from the lake as needed. The valves were operated by long rods housed in a masonry tower that rose from the eastern end of the culvert and projected above the surface of the lake, about 130 feet east of the dam. When the valves had to be opened or closed, the engineer rowed out to the tower and attended to them.

Disaster Averted. The spillway and valve system worked. In 1862, following ten years of neglect by the Pennsylvania Railroad, a breach began to open in the breast of the dam. Disaster was averted by opening the control valves and allowing the water to drain slowly from the lake, through the culvert. This breach was not immediately repaired, so the lake had not re-filled. By May 1879, when the dam was purchased by the South Fork Fishing and Hunting Club, what had once been the lake had become a large, grassy meadow.

The Dam is Rebuilt. The club repaired the breach and filled the lake. The pipes and valve tower were removed, and the culvert and earlier breach were haphazardly filled with wagon loads of dirt and shale. A bridge was built over the spillway. Screens were attached to the bridge supports which stood in the bed of the spillway to prevent the game fish, introduced into the lake at the Club's expense, from escaping downstream. The one-lane road across the breast of the dam, ten feet wide, was too narrow to allow carriages to pass in opposite directions. The club members found it inconvenient to wait at one end of the dam for oncoming traffic to cross, so the road was widened by lowering the breast of the dam two feet. The rebuilt dam, 931 feet long, 70 feet high, and 272 feet wide at the base, created a lake that covered 500 acres and was as much as 65 feet deep.

Concern Grows Downstream. The creation of Lake Conemaugh caused some concern for Johnstowners 14 miles downstream. The owners and managers of the Cambria Iron Company in particular were quite worried about the threat that the rebuilt dam and the 20 million tons of water behind it posed to their investments in the Conemaugh Valley, valued at nearly 50 million dollars.

An engineer from the Cambria Iron Company was sent to inspect the repaired dam. He concluded that the dam was not safe, and that a break was "only a question of time." The company offered to help with repairs to the dam to make it safer, but this offer was ignored by the club. On May 31, 1889, following weeks of uncharacteristically wet weather, the South Fork Dam failed.

A Lost Cause. In the hours before the break, workmen at the dam tried to open the spillway, but the screens placed between the supports of the spillway bridge had trapped logs, branches, and other debris. The spillway was almost completely blocked. Water backed up quickly, raising the lake level as much as two feet overnight. The center of the dam sagged slightly where the earlier breach had occurred, creating a low spot. When the water began to flow over this sag, it quickly cut down through the soft dirt and shale, opening a 450-foot-wide gap.

Warnings Unheeded. Telegraphed warnings that the dam was becoming dangerous went unheeded in the towns below. John Parke, the engineer for the South Fork Fishing and Hunting Club, rode through the valley on horseback, desperately pleading with people to move to higher ground. Johnstowners had heard these warnings before, and nothing had ever happened. Many were confident that the dam would hold.

Heroes. The dam failed at 3:10 p.m.. As the flood raced toward Johnstown, it was accompanied by many acts of heroism. Most of these heroes did not survive, but one often-told story is that of railroad engineer John Hess. He heard the terrible roar as the flood approached. He tied down the whistle of his steam locomotive as he raced into East Conemaugh ahead of the wave.

Flood and Fire. Less than an hour after the dam failed, the flood hit Johnstown. In just ten minutes, the city was in ruins. Fires broke out, ignited by household stoves, oil lamps, and boilers, and fueled by tons of debris that just minutes before had been houses and stores. At the Stone Bridge, just below the confluence of the Little Conemaugh and Stoneycreek Rivers, a mountain of debris caught by the bridge burned for two days.

The Toll. The official death count from the flood and fires was 2,209. Diseases such as typhoid fever claimed 40 more lives in the weeks after the flood. Property damage was estimated at 17 million dollars.

A City Rebuilds. News of the disaster spread quickly across the nation and the world, and relief efforts began almost immediately. All rules of decorum, as well as traditional political, religious, and social differences, were set aside. Clara Barton and the American Red Cross mounted their first major domestic campaign. The military was dispatched to assist with the clean up. Money and supplies poured in from across America and 16 foreign countries. The Cambria Iron Company reopened it mills within a few days of the flood, providing social stability and financial resources to the workers of the devastated city. Johnstown was rebuilt.

Nowhere to Go But Up – The Johnstown Incline. Many homes and businesses rebuilt on the narrow floodplain. As the city grew, more land was needed for the homes of workers and managers. The Cambria Iron Company owned a large tract of land above the city known as Yoder's Hill. The farms and pastures on Yoder's Hill supported some of the hundreds of mules and horses used in the company's mines and mills.

After the 1889 flood, the company decided to divide this farmland into plots for homes, with plans to build a school, store and hotel. This new development, known as Westmont, could only be reached by traveling a steep and winding road. It was not easily walked, and was difficult for horses and wagons to negotiate. In bad weather, the road quickly became impassable.

The solution, reminiscent of the old Allegheny Portage Railroad, was the Johnstown Incline. An inclined plane was constructed on the face of Yoder's Hill, powered by an engine housed at the top of the plane. Two counterbalanced cars were mounted on the tracks of the plane, attached to a cable that wound around machines at the top and bottom of the plane. The Incline was completed in 1891, and Westmont was recognized as a borough the following year.

The quickness, power, and destruction of the flood are almost impossible to comprehend, but the rate and extent of the recovery were even more remarkable. The flood of water and debris was followed by a flood of help and supplies from around the world. The people of Johnstown rebuilt their community.

Gotta See It! Johnstown Flood Sites

The Johnstown Flood National Memorial. The Johnstown Flood National Memorial is located in St. Michael and includes the ruins of the South Fork Dam. At this site, the National Park Service interprets the story of the South Fork Fishing and Hunting Club and its role in the flood.

The Johnstown Flood Museum. The museum, located in downtown Johnstown, is operated by the Johnstown Area Heritage Association and tells the story of the rebuilding of the city after the flood.

Visitor Center, Johnstown Incline. A good overview of Johnstown's topography and economic development is provided at the Visitor Center at the top of the Johnstown Incline.

The St. Michael Historic District. Part of the South Fork Fishing and Hunting Club's clubhouse, as well as several member's cottages, are still standing in St. Michael. These buildings are listed on the National Register of Historic Places. Tours of the clubhouse and some cottages may be arranged by calling the South Fork Fishing and Hunting Club Historic Preservation Society.

Downtown Johnstown. Johnstown has many reminders of its flood history throughout the downtown. For information on walking tours, contact the Johnstown Area Heritage Association.

Cambria City. This Johnstown neighborhood grew in the second half of the 19th century when thousands of immigrants came to work in the mines and mills of the Cambria Iron Company. The community has a proud ethnic tradition, and is the site of the annual Folk Fest. The Wagner-Ritter House, a small home located at 418 Broad Street, is presently being developed as a museum by the Johnstown Area Heritage Association. For more information on sites to visit in Cambria City, or to check on the progress of the Wagner-Ritter House, call the Johnstown Area Heritage Association.

The region's ethnic heritage continues in most of the churches and clubs throughout Cambria City. Call them for information on festivals, church tours, and other special events.

Bottleworks Ethnic Arts Center. The ethnic arts are celebrated at the Bottleworks Ethnic Arts Center in Cambria City. Classes and demonstrations of many traditional arts, as well as a variety of special programs, can be arranged. Call the center for more information.

Grandview Cemetery. Many victims of the Johnstown Flood were buried in the Grandview Cemetery. The sight of the rows of small tombstones in the Plot of the Unknown is a very powerful image and tangible link to the human toll of the flood. The cemetery was designed by the progressive 19th century architect Charles Miller, of Miller and Yates, who also designed the grounds of the 1876 Cenntenial Exposition in Philadelphia.

The Endless Story

The people of the Allegheny Ridge helped build a nation. They survived centuries of economic ups-and-downs, labor conflicts, wars, disasters, and transoceanic migrations. They built mind-boggling transportation networks and incredible manufacturing enterprises that were unrivaled in all the world. They danced and sang songs, raised families, and carried on ageless traditions. Their stories live on in the people and places of the Allegheny Ridge today. Their stories are here, waiting to be discovered.

[1] Frederick Overman, 1849, *The Manufacture of Iron, in All Its Various Branches*, (Philadelphia: Henry C. Baird).

[2] A BTU, or British Thermal Unit, is equal to 252 calories. A calorie is the amount of heat needed to raise 1 gram (or 1 milliliter) of water 1 degree Centigrade.