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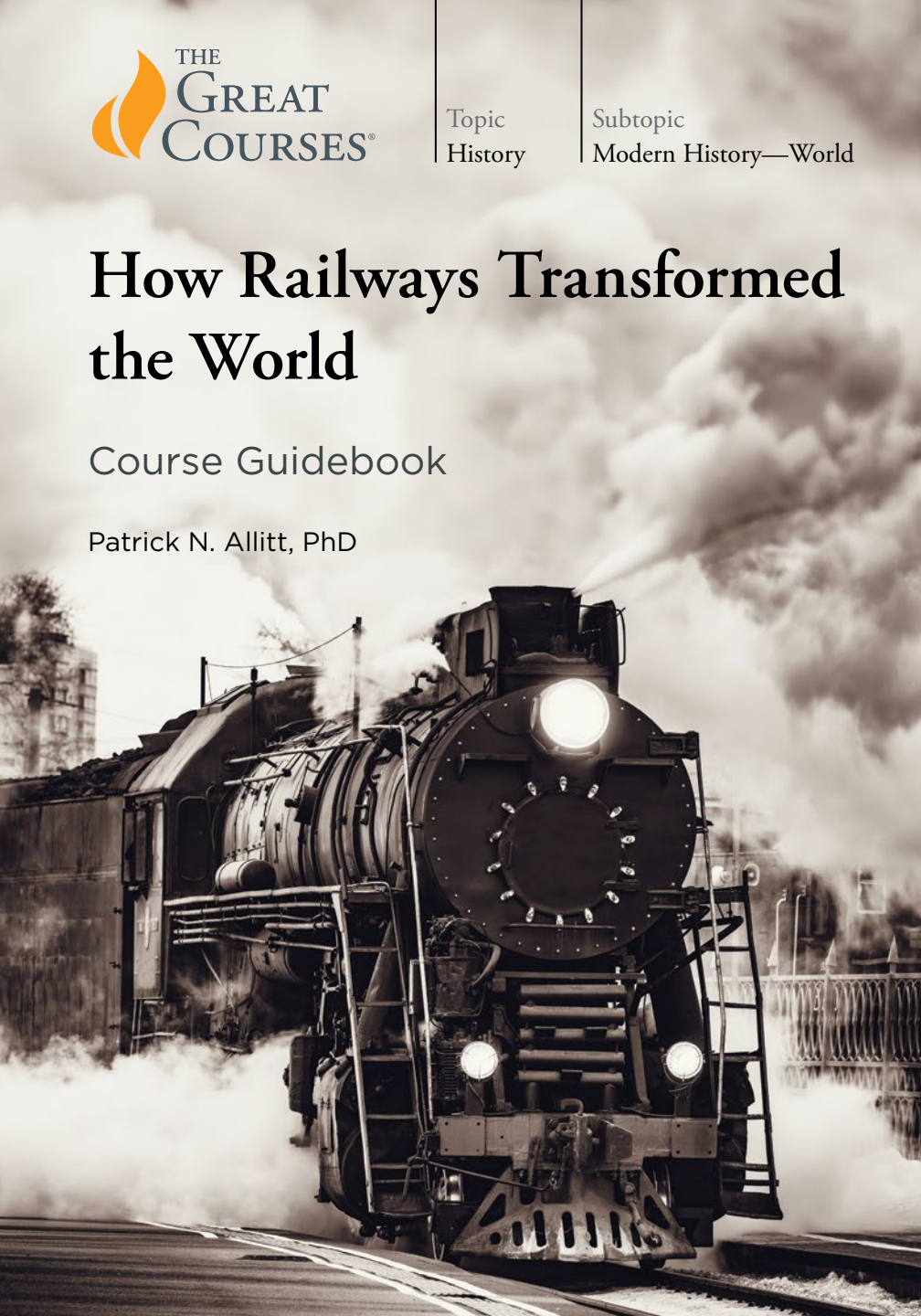
How Railways Transformed the World

Course Guidebook

Patrick N. Allitt, PhD



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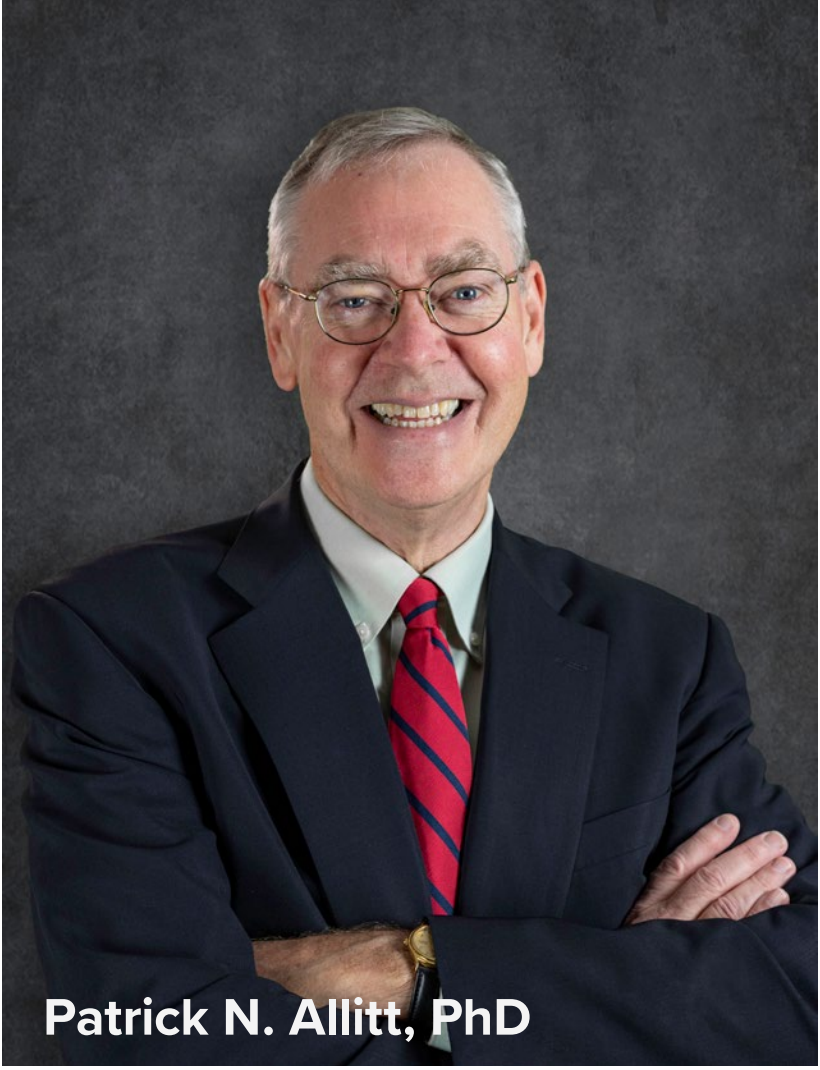

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The Idea of Railways

Railways are such a familiar part of the urban landscape in many places that it's easy to take them for granted. But when trains were first introduced, they were a revolutionary new technology, and they continue to play a vital role in the world today. In this course, you'll learn about the history of railways around the world, but as you'll see, when you study railways, you're also studying other things, including culture, economics, politics, and even psychology. To tell the fascinating history of railways is also to tell, in a compressed form, the world history of the last 2 centuries. This lecture takes a broad look at the development of railways and the impacts they had on various aspects of life.

EVOLUTION OF THE EARLY RAILWAYS

Railways were invented in the early 1800s, and they changed the world radically. They made it possible, for the first time, to move large numbers of people and volumes of goods overland at high speed and low cost. They have been central to industrial societies around the world ever since.

Nearly all the basic principles of railway technology had been worked out by 1825, and every subsequent improvement has been a refinement of one central idea—that smooth metal wheels running on smooth metal rails create a superbly efficient, low-friction environment. That's the secret to the success of today's bullet trains in Japan, running at 200 mph, just as it was the secret to the success of the Stockton and Darlington Railway, which began operations in 1825 and lumbered along at about 5 mph.

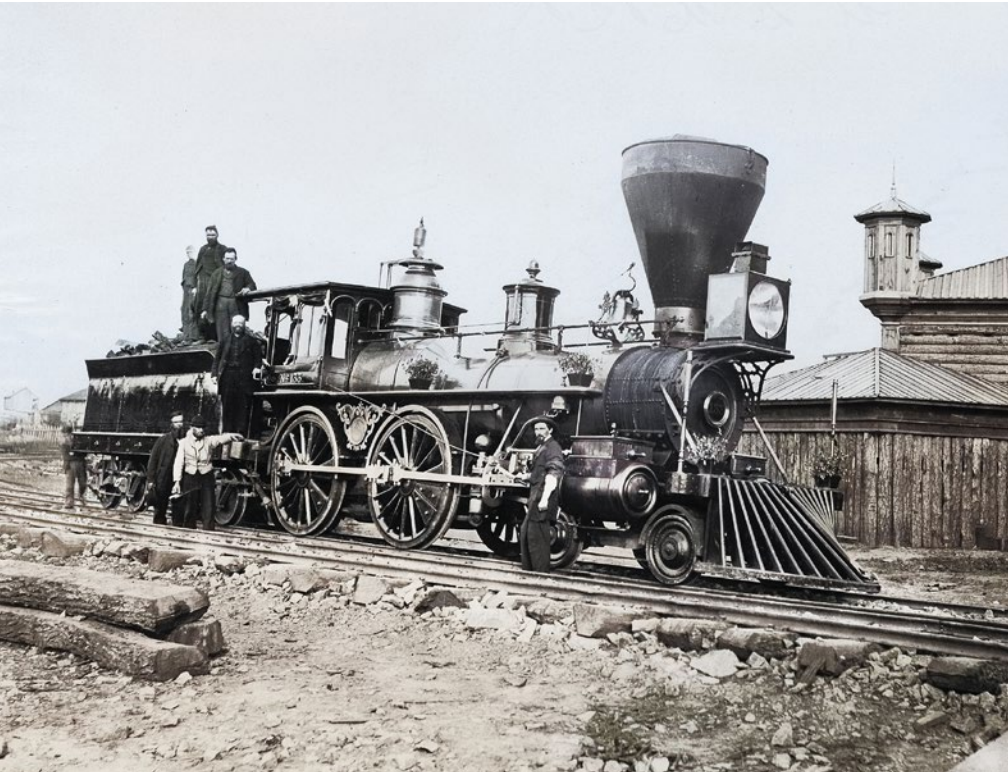
Already before 1800, there were scattered railways in Europe, mainly in coal- and iron ore-mining districts, with power provided by horses. The rails were usually wooden, as were the wheels that ran on them, making rapid wear and tear, plus rotting and burning, constant headaches. Improvements in bulk iron manufacture during the late 1700s permitted the first experiments with much more durable iron rails and wheels.

The next crucial invention was the locomotive. The first steam engines, dating from the early 1700s, were far too big to move and were used mainly to pump water out of coal mines. Improvements in steam engine efficiency in the late 1700s finally enabled a mining engineer from Cornwall, Richard Trevithick, to try mounting one on a vehicle. The energy of compressed steam pushing a piston inside a cylinder could now be used to move the vehicle. When such a vehicle was mounted on rails, it could attain greater speeds and achieve much greater pulling power than any horse.

The distance between two rails is called the gauge, and in England, it was nearly always 4 feet 8.5 inches, which was widely copied elsewhere and became known as standard gauge around the world.

Beginning in England in the 1820s, steam-powered railways caught on in Western Europe and the United States in the 1830s, then spread steadily over the next 7 decades. Imperial powers such as Britain, France, and Germany began building railways in their African and Asian colonies, opening new markets and new sources of raw materials and creating a durable infrastructure with implications right up to the present.

A journey across the United States, which took half a year by wagon train in 1850 and was often lethal, could be done by train much more safely and in less than a week by 1870.



Almost from the start, national governments realized the political significance of railways. For example, armies could move by train far more quickly than if they had to march. In most countries, accordingly, railways were not left solely to private enterprise but were subjected to high levels of state control.

IMPACTS ON CITIES AND SOCIAL ATTITUDES

Modern cities took shape around railways. They were such an efficient way of carrying large numbers of commuters in and out of cities each day that working people were able to live further away from their workplaces than ever before, making the siting of stations crucial. Older cities predating the railways, such as London and Paris, partially reoriented themselves around new station locations. Newer cities, such as Atlanta and Los Angeles, grew up around their railroad stations from the outset.

Trains also began influencing urban aesthetics. Realizing that stations were symbols of an exciting new world, railway builders made them much more spectacular than they needed to be. The great stations of London, above all St. Pancras, King's Cross, and Paddington, became some of the grandest, most recognizable buildings in the city. And the same can be said of Gare du Nord in Paris, Central Station in Milan, and Grand Central Terminal in New York. Some of these stations were rivaled only by the cities' cathedrals, whose architectural styles they sometimes echoed.

Meanwhile, trains first reflected and then modified social attitudes. A train, unlike a stagecoach, could carry hundreds of people at a time, many of whom wanted to differentiate themselves by social class. The idea of first-class travel arose almost at once, costing more but insulating passengers who could afford it from the other people on board. In India, separation of travelers was complicated not only by class, but also by caste, and there were five distinct classes of travel available on many Indian trains.

IMPACTS ON COMPANIES AND EMPLOYMENT

Railways also pioneered modern forms of business organization. First, they needed capital in unprecedented amounts. An individual could rarely undertake a railway-building project, so consortiums of businessmen pooled their resources, giving birth to the modern corporation. Throughout the second half of the 19th century, railways were the biggest companies in every country where they operated, attracting capital in the tens of millions of dollars and, perhaps inevitably, speculators, frauds, bribes, and political corruption.

Railway companies also employed more people than any earlier enterprise. From the outset, however, different groups of employees had conflicting ideas about fair treatment and approaches to safety. Trade unions arose among railway employees in nearly every country. The rail industry helped to shape modern labor relations. It also gave birth to middle management, creating a class of employees who worked in white collars, sometimes hundreds of miles distant from their employers, and who had to be trusted to handle large sums of money and keep the peace between owners, laborers, shippers, and passengers.

Railways helped create the concept of the career path, in which an individual started working for the company as a teenager and stayed on for decades, acquiring promotions and seniority and at last retiring and being acknowledged for their lifetime of service.

IMPACTS ON ENGINEERING

Trains, by their very nature, inspired further advances in technology and engineering. For example, special technical challenges arose when railways had to climb mountains or cross mountain ranges. These situations often required awkward remedies such as switchbacks, on which trains had to zigzag back and forth laboriously to gain the necessary altitude.

Some railways depended on long tunnels to go through the mountains, and the early history of tunnel building is fraught with tales of tragedy and death. The toughest mountain terrain, such as the Swiss Alps, sometimes required rack-and-pinion railways, in which a central third rail with serrated teeth engaged cog wheels on the locomotives to gain the necessary traction.

Mountain railways also came with the larger problem of winter conditions. Ice and snow were often daunting, at first requiring huge crews to dig trains out of the snow; before long, engineers devised innovative devices such as the rotary snowplow, which could chew its way through heavy snowpacks to keep lines open no matter the weather.

DECLINE AND RECOVERY OF RAILWAYS

Railways reached their greatest extent around 1890–1920. After the 1920s, trains faced three new rivals: aircraft and cars for passengers and trucks for freight. These challengers picked up the pace in the years between the two world wars and began to displace the railways after World War II, making it seem that railways were doomed to decline and disappear. Such thinking was the standard wisdom in the 1960s and 1970s, when American railways started to go bankrupt, and none could find a way to run passenger trains at a profit.

History is full of surprises, however, and since about 1980, railways have begun to stage a comeback, such that their future now seems assured. This is partly because the environmental costs of a civilization based on motor vehicles started to add up. The fuel crises of 1973 and 1979 dispelled assumptions that petroleum would always be plentiful and cheap. Besides, cars need a lot of space for parking, they clog roads in cities, and they pour greenhouse gases into the atmosphere.

Trains, by contrast, don't suffer traffic jams, don't have to be parked, and are far more efficient than cars in terms of fuel burned per passenger mile. So, in recent decades, commuting by rail rather than road has begun to seem much more attractive—especially for the millions of suburbanites who work in major cities.

Meanwhile, let's not forget the sheer pleasure of trains. The smooth level effect of a train ride, combined with the big windows, is comparable to sitting in a cinema watching the movie unfurl before your eyes. And when the journey ends, there's no waiting for the people in first class to disembark before you, no waiting beside a grinding luggage carousel, and no lengthy trudge from the airport into the city it serves. Instead, you instantly stand up, go through the door onto the platform, and walk out into the city's center.

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And instead of passing by the fronts of houses, factories, warehouses, and dockyards, railway travelers usually get to see the much more interesting, varied, and intimate backs of places otherwise inaccessible to curious sightseers.

Then, of course, there are those unforgettable journeys through spectacular places like Africa or Alaska. Such excursions remind us that railways are more than just a way of getting around quickly and efficiently. They are something to admire in themselves. The great bridges and stations that transformed the landscape are achievements of lasting significance, and they have been making a deep impression on travelers, artists, and photographers for nearly 200 years.

READING

Faith, Nicholas. *The World the Railways Made*. London: Head of Zeus, 2014.

Holland, Julian. *The Times Great Railway Journeys of the World*. London: HarperCollins, 2015.

Lambert, Anthony. *Lost Railway Journeys from around the World*. London: White Lion, 2018.

2

Britain's Railway Pioneers

Two projects in Britain initiated the railway age: the Stockton and Darlington Railway, which opened in 1825, and the Liverpool and Manchester Railway, which opened in 1830. George Stephenson, a self-taught engineer and inventive genius, played a central role in both projects, and most historians give him credit for bringing together the insights of dozens of other inventors to create recognizable working railways. This lecture explores how Stephenson and others, including his son, brought their vision and experience together during this exciting time in railway-building history.

EARLY STEAM LOCOMOTIVE PROTOTYPES

George Stephenson, like most of the men who developed steam locomotives, worked at a coal mine. That's not surprising because one of the earliest uses of steam power, before railways were invented, was to pump water out of flooded mines. Thomas Savery and Thomas Newcomen had built the first steam engines at the turn of the 18th century. These engines weighed hundreds of tons, were often 3 stories high, and ran at only 2 or 3 strokes per minute. James Watt, whose name is still invoked when measuring power in watts, improved the Newcomen engine in 1776. He made it faster, more efficient, and smaller.

Newcomen and Watt set the stage for Richard Trevithick, a mining engineer from Cornwall who experimented with miniaturized steam engines and with attaching them to vehicles. One of his first prototypes, an experimental steam-powered road carriage called the Puffing Devil, caught fire during an early trial and consumed itself, but in 1804 he built a recognizable locomotive and ran it on rails at Penydarren in South Wales, pulling a 10-ton load of iron. It worked, but its weight broke some of the rails, which had been designed for much lighter, horse-drawn vehicles. A replica of this locomotive now stands at the National Waterfront Museum in Swansea, South Wales, and is fired up for short rides outside the museum several times each year.

Trevithick also built a steam engine for an ironworks at Coalbrookdale in Shropshire, near what is today one of Britain's best museums of industrial history. There's some doubt about whether the original actually ran, but the replica, with its distinctive large flywheel and interlocking cog wheels, offers a lively sense of how Trevithick set about using high-pressure steam to create circular motion.

The Beamish Museum in County Durham, another mecca for fans of early industrial history, runs the replica of a third early steam locomotive, the *Puffing Billy*. It was built by William Hedley in 1813, and instead of the Trevithick flywheel, it has a pair of vertical cylinders attached to reciprocating beams.

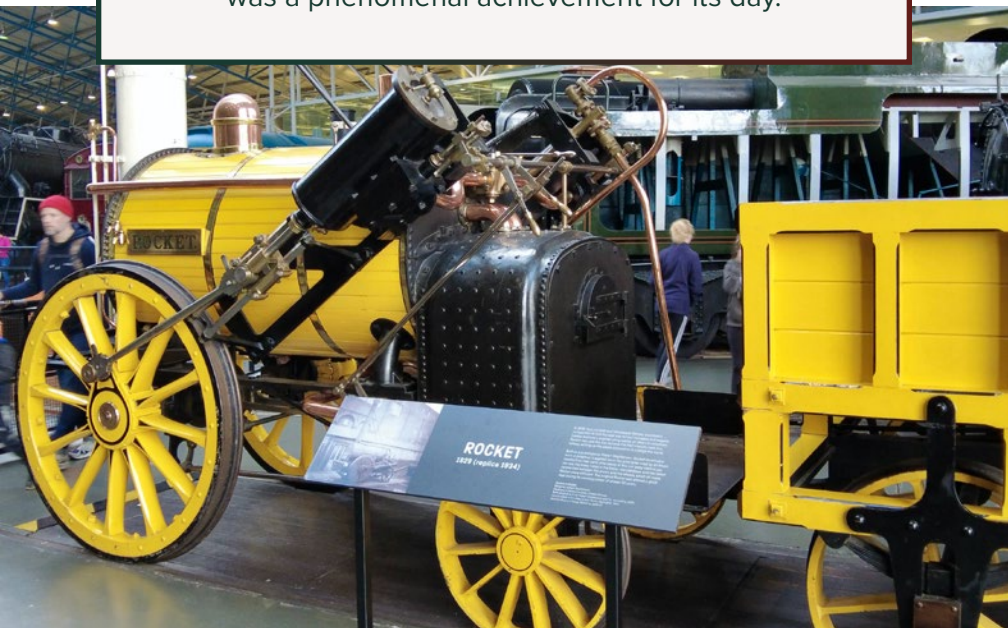
The original *Puffing Billy* is the oldest surviving steam locomotive in the world and can be found at the Science Museum in Kensington.

THE LIVERPOOL AND MANCHESTER RAILWAY

George Stephenson, who was born in 1781, built on the achievements of Watt, Trevithick, and Hedley. He was appointed chief engineer of the Stockton and Darlington Railway in 1822, another coal-moving enterprise. He surveyed and built the line with the help of his talented son, Robert, and their engine, named *Locomotion*, pulled the first train when the line opened in 1825. That engine now takes pride of place in the annex of the National Railway Museum in Shildon, where it keeps company with some of the most innovative trains in British history.

After his work on the Stockton and Darlington Railway, George Stephenson's next step was to design and build the Liverpool and Manchester Railway, a more sophisticated project that linked a major port with a major manufacturing center. The directors of the new railway held an open competition for the contract to supply the railway with its engines. Known as the Rainhill trials of 1829, locomotives were required to pull three times their own weight over a distance of 35 miles, moving back and forth repeatedly over a 1-mile section of track within sight of the judges. Ten engine builders expressed interest, but only five brought working engines to Rainhill, one of which was powered by a horse on a treadmill.

The *Rocket* is probably the world's most famous steam locomotive. It seems almost a toy beside the massive later engines that stand with it today in the National Railway Museum in York, but it was a phenomenal achievement for its day.



A crowd of more than 10,000 people came to watch. Only one locomotive completed the assignment. It was the *Rocket*, built by George and Robert Stephenson, who won the competition and the lucrative contract.

The *Rocket's* history is marred by the fact that, on the official opening day of the Liverpool and Manchester Railway in 1830, in the presence of the prime minister and other dignitaries, it struck and killed William Huskisson, a senior government officer. A stone marker commemorating his life and death stands close to where the accident took place.

Despite that accident, the railway was a commercial success. Not only did it accelerate trade between the two cities, but it also became popular as a passenger railway. What had once been most of a day's journey could now be done in little more than an hour.

RAILWAY MANIA

Following the success of the Liverpool and Manchester Railway, the 1830s and 1840s witnessed the rapid building of lines throughout Britain linking the major cities. Then came the building of branch lines connecting the major cities to smaller towns between 1850 and 1890. With stops, starts, scandals, and hiccups along the way, however, a network of 13,500 miles had been built by 1870, and 20,000 miles by 1914. Its effects transformed nearly every aspect of British life.

In the 1830s and early 1840s, the British government did not contribute funds or land to railways. The initiative came from private investors, who formed joint-stock companies. Shares could be bought and sold on the London stock market and at regional stock markets in other cities. The promoters would then seek an Act of Parliament

Railway mania was the term used in the 1840s to describe investors who got carried away by exaggerated claims made on behalf of lines that were destined never to be profitable.

to authorize their scheme. The act would give them access to the entire route, including the right to take land held by many different owners, with appropriate compensation. Such was the principle of eminent domain, by which land transfers can be compelled when a project is deemed to be in the national interest.

The parliamentary acts also gave investors limited liability, which meant that if the railway went bankrupt, they would lose their investment but would not be responsible for paying off additional debts. Limited liability obviously stimulated more investment and encouraged economic growth, though it also removed an important restraint against reckless spending.

George and Robert Stephenson were in demand everywhere. In the early 1830s, Robert accepted the job of designing and building the very important line between London and Birmingham, a major manufacturing center in the middle of England. It would be 112 miles long.

Building on experience gained on the Liverpool and Manchester Railway, Stephenson again chose to use a gauge of 4 feet 8.5 inches, which soon became known as standard gauge and would be approved for use throughout Britain in 1846. The London and Birmingham line opened in 1838 and was soon linked to other lines that would carry passengers on to Liverpool, Manchester, and Sheffield.

Apart from being a brilliant civil engineer, Robert Stephenson was almost certainly the best locomotive builder in the world at the time. His greatest rival in the 1830s was Isambard Kingdom Brunel, the son of a prominent engineer who designed the first tunnel under the river Thames. Isambard Brunel designed and built the Great Western Railway between London and Bristol and later extended it to the West Country cities of Exeter and Plymouth and into South Wales. Ignoring the Stephensons' accumulated experience and the advantages of standard gauge, he decided to build the Great Western to 7-feet gauge for the sake of greater comfort. The difference in gauges between Brunel and everyone else meant that freight needing to be transferred from the Great Western to another line at meeting points such as Gloucester had to be laboriously unloaded from one set of wagons and then reloaded onto another.

One can see remnants of Brunel's 7-foot gauge at two museums along the route of his Great Western Railway. The first is at Didcot and the other is at Swindon, in the old railway works, where there's also a superb replica of *North Star*, one of his famous early engines.

One of the central figures of railway mania was a Yorkshireman, George Hudson, nicknamed the Railway King. His background was in the drapery business and regional banking; he knew little or nothing about the technical side of railways. He did, however, have the foresight to realize that England's countless small railways needed to be consolidated into fewer and bigger networks. He helped set up the Railway Clearing House in 1842, a cooperative scheme to facilitate the wagons and carriages of one company traveling over the tracks of another.

Hudson presided over many mergers, too, gradually acquiring a large share in the major railway companies of central and northern England. He mastered a wide range of business practices that are now illegal but were not then regulated. Only when the railway mania bubble burst in 1849 were Hudson's practices revealed and condemned. He was forced to resign his directorships and only escaped prison by fleeing abroad.

A PERIOD OF CHANGE

Change was visible across Britain. Towns such as Swindon, Wolverton, Doncaster, Middlesborough, and Derby grew rapidly as railway construction and maintenance centers. The big industrial cities grew bigger still, as railways accelerated the urbanization of British life. Now it was possible for manufacturers to market their goods nationwide, and it was also possible for inland coal fields to be developed because the coal could be taken to market by train.

These developments affected labor, too. During the late 1840s, 250,000 men were at work building railway lines, and soon huge numbers would be working as drivers, firemen, brakemen, station masters, signalmen, freight handlers, and track maintenance men. Apart from agriculture, railways were the nation's biggest employer by 1860.

Two contradictory forces clashed in this period. One was the need for precise and disciplined management, for the sake of safe operation. The other was the high-risk, high-return temperament of the railway financiers, who were essential to the whole project but rarely knew much about actual operations.

Interestingly, the British government did not take any initiative to plan and build railways of its own. America generally followed the British path of free enterprise whereas most of the European nations saw a high level of political involvement right from the start.

READING

Brindle, Steven. *Brunel: The Man Who Built the World*. London: Phoenix, 2006.

Simmons, Jack. *The Victorian Railway*. London: Thames and Hudson, 1991.

Smiles, Samuel. *Lives of the Engineers: George and Robert Stephenson*. 1862. London: CreateSpace, 2016.

3

The First American Railroads

By the time the Liverpool and Manchester Railway opened, the American War of Independence was a distant memory. Britain and America were now partners in a lucrative commercial relationship as American cotton from the plantation South flowed into Britain's textile factories, much of it over railways. This lecture looks at the development of railways in the United States, including some of the unique challenges that confronted American engineers.

THE BALTIMORE AND OHIO RAILROAD

American observers visited the Stockton and Darlington and the Liverpool and Manchester railways in the late 1820s. At least one American, E. L. Miller, a merchant from Charleston, South Carolina, was present at the Rainhill trials to see the triumph of the Stephensons' *Rocket* in 1829. Horatio Allen, an American engineer, got to know Stephenson during a visit to England and bought two of his locomotives, the *Stourbridge Lion* and the *Pride of Newcastle,* for the Delaware and Hudson, one of America's earliest lines.

In America, there were few good roads, and communications were slow and difficult except by river and sea. Its population, recorded as 12.8 million in the 1830 census, was still mostly scattered along the Eastern Seaboard. New states west of the Appalachians—Kentucky, Tennessee, Ohio, and Indiana—were growing fast, but the mountains made them hard to reach from the East Coast.

One of the most ambitious American railway projects was the Baltimore and Ohio (B&O) Railroad, chartered by the Maryland state government in 1827. Its operations began on a short section of track in Maryland in 1830. Peter Cooper, an inventor and philanthropist, built a small locomotive called *Tom Thumb*. It lacked the design sophistication of the *Rocket*, but it clattered along at 18 mph on its trial run in 1830 and impressed the B&O directors. A full-size replica of *Tom Thumb* is on display at the B&O Railroad Museum in downtown Baltimore.

The B&O Railroad Museum is one of the best places in the United States to see relics of early American railroading. It uses a locomotive roundhouse, built in 1884, and has an unequaled collection of pre–Civil War locomotives.

The B&O Railroad aimed to cross the Appalachians, which are higher than any British mountain range. That would require sophisticated surveying, tunneling, and bridge building. The line's ultimate target was Wheeling, West Virginia, on the Ohio River, which would give the promoters a share of the trans-Appalachian trade that was currently going mostly to New York via the Hudson River and the Erie Canal.

Much of the proposed route had never been cultivated or settled, so the land was easier and cheaper to acquire than in Britain. But progress was slow—it didn't reach Wheeling until 1853, after nearly 25 years of laborious effort. Among its landmarks was the first bridge at Harpers Ferry, a dramatic setting at the confluence of the Potomac and Shenandoah Rivers.

EVOLUTION OF LOCOMOTIVE TECHNOLOGY

It's impressive to see how quickly the technology developed. The locomotive *Lafayette*, from 1837, less than 10 years after Peter Cooper's *Tom Thumb*, had already adopted most of what became the characteristics of the standard design from then on: long boiler, smokestack at the front, horizontal cylinders close to the ground, and additional wheels to distribute the weight. The enclosed cab for the driver and fireman appears on the *Memnon*, from 1848, which shows another great leap forward in sophistication and has eight linked driving wheels.

Another important early American locomotive, the *John Bull*, is on display at the Smithsonian's National Museum of American History in Washington DC, and a replica is on display at the Railroad Museum of Pennsylvania in Strasburg, Pennsylvania. It was built by Robert Stephenson in Newcastle, England, in 1831 and imported by the Camden and Amboy Railroad, the first steam-driven line in New Jersey. When Stephenson sent the components in crates, he forgot to include instructions for assembly. An ingenious mechanic named Isaac Dripps tinkered with the parts and eventually assembled them into a working engine. It enjoyed a 35-year working career and became the Smithsonian's first major industrial display.

Isaac Dripps was among those who developed the cowcatcher, the distinctive wedge-shaped prow of most early American engines. It was designed to deflect animals away from the track and reduce the danger of an engine derailment.

TRAINS VERSUS CANALS

Numerous American railways began in the early 1830s. Another was the Mohawk and Hudson, which linked the Great Lakes to the Hudson valley and New York City. The Erie Canal, which had opened in 1825, was in danger of being eclipsed by the railroad after only 5 or 6 years of operation. Trains were faster than canal boats, could carry comparable loads, and did not have to negotiate locks. Above all, they did not have to cease operations for 3 or 4 months every winter when upstate New York's frigid conditions turned waterways to solid ice.

The Mohawk and Hudson's best-known locomotive was the *DeWitt Clinton*. It was American built and pulled modified stagecoaches mounted on railway wheels. A replica was built for the 1893 World's Columbian Exposition in Chicago and is now on display at the Henry Ford Museum of American Innovation in Dearborn, Michigan. The Mohawk and Hudson line itself is still in service today as part of the CSX system.

Philadelphia's business community, as eager as the men of Baltimore to compete with New York, began to build the Pennsylvania Railroad from their city west to Pittsburgh. Until it was finished in the mid-1850s, they had to make the journey across Pennsylvania by canal. Locks can elevate a canal, but where the mountains were steepest, the canal company substituted a set of inclined planes interspersed with flat sections of railway. A section of this fascinating hybrid of canal and railway, the Allegheny Portage Railroad, has been preserved near the city of Altoona; it's now run by the National Park Service. Canal boats, sometimes divided into three detachable sections, would be loaded onto rail cars, then dragged up the first inclined plane by ropes attached to a stationary steam engine, then pulled by horse or locomotive along the flat section to a second inclined plane, and then dragged up by another stationary steam engine, and so on. When railroad tracks were built across the mountains, the hybrid system was rendered obsolete.

The Pennsylvania Railroad came to dominate the state and to establish connecting lines in New York, Maryland, Ohio, Illinois, Indiana, and Michigan. After a shaky start before the Civil War, the Pennsylvania Railroad later gained a reputation for good management, state-of-the-art rolling stock, and advances in safety under the leadership of J. Edgar Thomson. By 1874, the year Thomson died, it was the single biggest business enterprise in the entire United States.

TELEGRAPH AND THE RAILWAYS

One man who grew immensely wealthy through service to the railways was Andrew Carnegie. Born and raised in Scotland, his family emigrated to Pittsburgh when he was 12, and before long, he was hard at work on the Pennsylvania Railroad. In the 1850s, he became a telegraph operator, sending and receiving messages in Morse code from stations along the track.

The electric telegraph was invented by Samuel Morse. Its feasibility over long distances was confirmed in 1844 when Morse transmitted a message from Washington to Baltimore. The wires followed the path of the Baltimore and Ohio Railroad, and the message "What hath God wrought?" was received in the station that is now the site of the B&O Railroad Museum.

Telegraph was an immensely useful invention for the railways because they needed a quick and reliable method of communicating up and down their tracks. If a train derailed or was delayed, telegraph messages could let signalmen know, helping them prevent collisions. By the late 19th century, telegraph wires were strung alongside almost every railroad track.

THE DANGERS OF EARLY RAILWAYS

Even with the telegraph, however, early American railroads were dangerous and accident prone. They were built more hastily and to a lower technical standard than their British counterparts. Apart from the workers who died building tracks, the first known American railroad casualty was an enslaved man working as a fireman on board a locomotive called the *Best Friend of Charleston*, whose boiler exploded one day in June 1831. The South Carolina Railroad responded to passengers' fears that they might be killed in another explosion by placing a wagon piled high with cotton bales between the locomotive and the cars. They called it the barrier car.

The fatality rate increased sharply in the 1850s as the lines got longer, as speeds increased, and as more trains ran at night. It stayed high from then on. The cars were made of wood, were flimsy, and often shattered on impact or caught on fire. Not until the dawn of the 20th century would major

improvements come about, fostered by increased political oversight, systematic reporting of accidents, and, above all, the introduction of steel cars in 1907.

One man who witnessed plenty of early railroad mishaps was young Andrew Carnegie. By age 24, he had been made superintendent of the Pennsylvania Railroad's Pittsburgh division. He would later contribute to railroad safety by developing high-quality steel rails that were less brittle and more durable than their cast-iron predecessors.

In 1833, former US president John Quincy Adams was involved in a train accident in New Jersey. He was unhurt, but a fellow passenger, Cornelius Vanderbilt, nearly died after being flung from the derailed train. Cornelius survived and went on to make an immense fortune in railroads.

Nearly all the jobs on the early railroads were new, being learned for the first time by people who sometimes had to work out techniques as they went along. Whereas early industrial factories in that era tended to concentrate a lot of workers under the same roof so that owners could watch them working, railways distributed workers over great distances and required them to show the right combination of discipline and initiative even when they were out of sight.

Railroads, moreover, developed in the era of Jacksonian democracy in the 1830s and 1840s, when American men asserted their equality and tended to resist discipline imposed on them by anyone else, including management. Such an attitude was highly unconducive to running railroads. Complex organizations need close coordination and cooperation among large numbers of people, all of whom accept and live by explicit rules. Europe had greater success with this sort of top-down coordination. But in the young United States, only very slowly over the course of the 19th century would its workers be forced to accept this new reality.

READING

Dilts, James. *The Great Road: The Building of the Baltimore and Ohio, the Nation's First Railroad, 1828–1853*. Stanford: Stanford University Press, 1993.

Holbrook, Stuart. *The Story of American Railroads*. 1948. New York: Dover, 2016.

Stover, John F. *American Railroads*. Chicago: University of Chicago Press, 1991.

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Early European Ventures

Once the Liverpool and Manchester line had shown railways to be viable and profitable, they caught on in Europe, as in America. But there were differences. In Britain, the railways enriched a nation that was politically stable; in Europe, which was volatile and fragmented in the 19th century, railways helped create new nations. This lecture explores how railways developed in countries such as Belgium, Germany, France, and Italy and how the process connected not just city to city but country to country. It also highlights several remarkable feats of engineering, including viaducts and tunnels that are still in use today.

RAILWAYS OF BELGIUM

Among Europe's new nations was Belgium, which became independent only in 1830, when it broke away from the Netherlands. It was linguistically divided between French and Flemish speakers, and it lacked navigable waterways. Its government, under King Leopold I, saw railways as a way to stimulate economic growth and promote national unity. Advised by George and Robert Stephenson, and buying equipment and expertise from Britain, Belgium opened its first line, between Brussels and Mechelen, in 1835.

To look at pictures of the first steam trains in Belgium, Holland, Germany, and France is to see variations of Stephenson locomotives. Rapid design progress after the *Rocket* led to the *Planet* of 1830 and then the *Patentee* of 1833, whose wheelbase of two leading wheels, two big driving wheels, and two smaller trailing wheels increased stability, distributed the load to reduce wear on the tracks, and proved a highly serviceable and durable arrangement. Germany's first locomotive, the *Adler*, was of this type, as was *De Arend*, first on Dutch railways, and *Le Belge* in Belgium. *Le Belge* was the first locomotive built in Belgium, in 1835. Its builder was John Cockerill, son of a British émigré and one of Belgium's pioneers in iron and steel manufacturing.

Before long, Belgium shook off its early dependency on Britain. It planned and built railways to link up its major cities and industrial districts, using home-built equipment, and it would be the first country to have a fully nationalized system. Belgium became a major manufacturer and exporter of locomotives and other railway equipment.

A line linked Brussels with Paris in 1846, making them the first two national capitals to be joined by rails.

RAILWAYS OF GERMANY

The first steam-operated line in Germany, from Nuremberg to Fürth in Bavaria, opened in late 1835, alongside a busy road. Many other lines followed in the late 1830s, at a time when Germany still consisted of 39 separate states. The first fully steam-driven, double-tracked major line, from Leipzig to Dresden, 75 miles long, opened in 1839. It included the first standard-gauge railway tunnel in continental Europe. Its surveyors were British, but the chief engineer was German, Karl Theodor Kunz.

One of the champions of the Leipzig–Dresden line was the economist Friedrich List, a tireless advocate of railways as the way to unite Germany. The success of the line encouraged businessmen and state governments throughout Germany to undertake lines of their own. Among the lasting achievements of the 1840s is a series of magnificent railway bridges.

The Göltzsch Viaduct, built in the late 1840s as part of a line connecting Saxony to Bavaria, remains the world's largest brick bridge. More than 1,700 men worked on it for 5 years, using 50,000 bricks each day. The viaduct is still in use today, with trains crossing at almost 100 mph.

In 1846, the railway chiefs of Germany's major lines created an organization, the Union of German Railway Administrations. It built on the Zollverein agreement of 1833, an initiative to reduce interstate tariffs and create a free trade area throughout Germany. This combination of technological and political initiatives all helped lay the groundwork for German unification.

Otto von Bismarck was the political genius who finally unified Germany. Becoming prime minister of Prussia, already the biggest of the states, in 1862, he worked systematically toward this goal and triumphed in 1871. He recognized that railways would work best if their track, locomotives, safety procedures, and labor rules were all standardized and if trains could travel anywhere in the country at short notice. Bit by bit through the 1870s, Germany's railways were integrated into a single system. Private owners were compensated, and from then on, military rather than commercial considerations predominated.

RAILWAYS OF FRANCE

France was, like Britain, already politically unified in 1830, but its railway system developed more slowly. France had a much better system of roads than Britain and a good network of canals. Their owners mobilized in the French National Assembly to obstruct the passage of railway legislation. France was also less industrialized than Britain and still more dependent on farming, so the need for railways was less acute. And because its banking system was also less developed, French railway projects found it more difficult than their British counterparts to raise the necessary money. But a pioneering line from Paris to Le Pecq opened in 1837. It was only 12 miles long, but it drew crowds of passengers right from the start, made a profit, and confirmed France's potential as a railway nation.

By 1849, it was possible to travel between London and Paris, using trains and steam ferries, in just 8.5 hours.

The French government played an active role in shaping a national French network. Throughout much of the country, the government would plan routes, acquire the land by compulsory purchase, and build the track bed, the bridges, and the tunnels. Private companies, each dominant in its own geographical region, would then lay the rails and run the trains. They often raised the necessary capital from English investors, who tried to protect their investment by specifying that English engineers must be appointed to carry out the work.

Many of France's early locomotive types can be found in Cité du Train, the French national railway museum in the Alsace town of Mulhouse. It's the best place to see how France, starting like Belgium with British-built locomotives, soon branched off to develop an indigenous tradition of locomotive design.

RAILWAYS IN RUSSIA

Tsar Nicholas I approved the building of a 17-mile line between his summer palace in Tsarskoye Selo and St. Petersburg. It opened in 1837 and was very much to his liking.

Far more controversial was his order for a line to be built between Moscow and St. Petersburg, a distance of 400 miles. Its chief engineer was George Washington Whistler, who had gained a good reputation as an American railway builder and was recruited to apply American expertise to the task. He died of cholera before the job could be finished, leaving behind a son, James McNeill Whistler, who became one of the century's most celebrated painters.

Thousands of serfs died, too, but the line, when completed, was built to high standards and double-tracked throughout. The line opened in 1851 and was, for a while, the longest railway in the world. Opponents feared it would encourage ordinary people to travel and would promote revolution. Stringent police regulations in the early days governed who was allowed to ride; in effect, that meant none but members of the privileged Russian elite. Army sergeants were the conductors and ticket collectors.

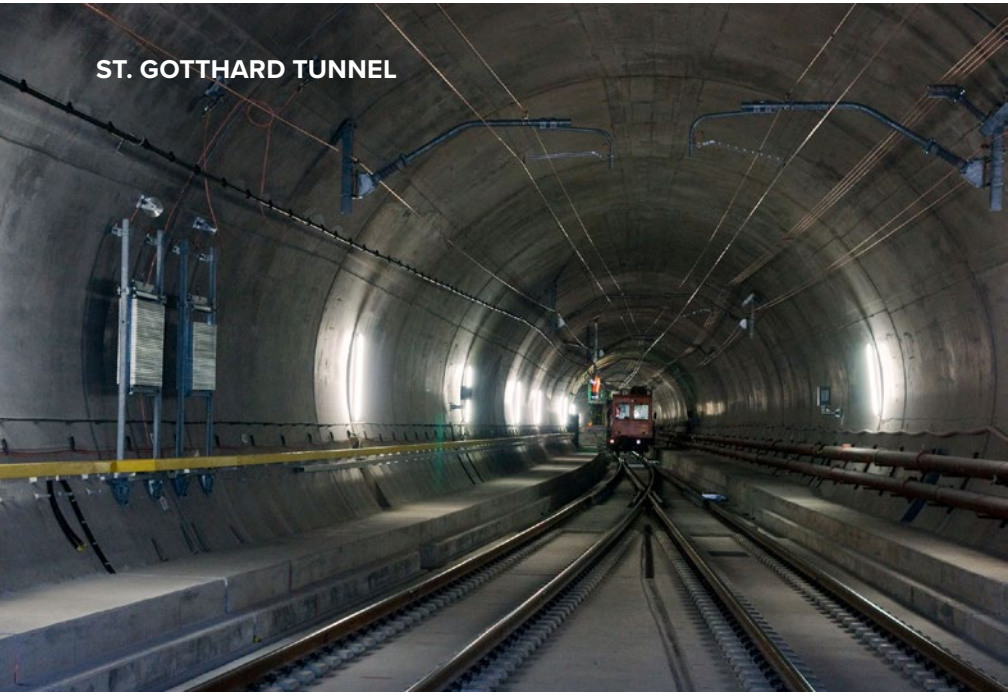
RAILWAYS THROUGH THE ALPS

From about 1860, more lines were planned to link up Europe's nations. It was easy enough to build from Germany into Holland or Belgium, for example, on low and level terrain, but much more difficult to build between France or Germany and Italy. Standing squarely in the way was the Alps, western Europe's highest mountain range. Austria undertook a standard-gauge Alpine railway crossing at the Semmering pass, between 1848 and 1854, which featured another of the most beautiful bridges of the era, the Kalte Rinne Viaduct, incorporating an elegant curve and a sequence of tunnels. The line, almost unchanged, is still in use today. It linked up the Austrian capital of Vienna with the city of Trieste, which is now part of Italy but was then the Austro-Hungarians' major Adriatic Sea port. A second line further west across the Brenner Pass and built in the 1860s strengthened this trans-Alpine link.

Two impressive tunnels burrowed through the Alps and into Italy: the Mont Cenis and the St. Gotthard. The Mont Cenis Tunnel was 8 miles long and took 14 years to build, between 1857 and 1871. It would have taken even longer had it not been for the resourcefulness of its chief engineer, Germain Sommeiller. In addition to refining recently developed pneumatic drill technology, Sommeiller employed dynamite, which had been patented by Alfred Nobel in 1867. When work began, both ends of the tunnel were parts

of the kingdom of Sardinia. By a treaty of 1860, the western end became part of France, but work continued unabated. When tunnelers from the two ends met on the day after Christmas 1870, they were just a few centimeters out of alignment, a fine tribute to Sommeiller's accurate dead reckoning and consistent good workmanship.

The 9-mile-long St. Gotthard Tunnel in Switzerland created a direct route from Germany in the north and Italy in the south. The St. Gotthard Pass was one of the oldest crossings of the Alps, but it was hazardous, often closed for long periods each winter. In the late 1860s, Alfred Escher, an ambitious Swiss entrepreneur and politician, recognized the economic benefit to Switzerland of replacing it with a standard-gauge railway link, despite the need for a long tunnel. He pushed the necessary legislation through the Swiss parliament and supervised the raising of capital from German, Swiss, and Italian sources.



ST. GOTTHARD TUNNEL

Work began in 1872, with Louis Favre, a self-taught Swiss engineer, in charge of the project. To get the railway up to the entrance of the main tunnel, at an altitude of about 3,600 feet, he had to build several other tunnels, in some of which the trains gained altitude on gently inclined spirals. Favre used state-of-the-art equipment, including dynamite and pneumatic drills, which enabled him to progress at about one-third of the cost per mile incurred on the Mont Cenis Tunnel. Still, the project was so stressful that Favre himself aged visibly. During a visit to the work in progress in 1879, he died suddenly in the tunnel; he was only 53 years old. The tunnel was completed the following year and opened in 1882.

The St. Gotthard line became one of the great arteries of European commerce. It was in many ways the capstone to a process that, between 1830 and 1880, transformed Europe more rapidly than its collective changes of the preceding 500 years.

READING

Mitchell, Allan. *The Great Train Race: Railways and the Franco-German Rivalry*. New York: Berghahn Books, 2000.

Wolmar, Christian. *Blood, Iron, and Gold: How the Railroads Transformed the World*. New York: Public Affairs, 2010.

5

Railways Go to War

The world of the mechanics and engineers who built the first railways was remote from the world of army officers, but in the middle of the 19th century, these two worlds began to converge. This lecture examines the impact railways had on several conflicts, including the Crimean War, the American Civil War, the Franco-Prussian War, and the Boer War. Sometimes the side with the better railway system won—but not always. These conflicts alerted generals and politicians to an important new reality.

THE CRIMEAN WAR

The British army, allied to France and Turkey, went to war against Russia in 1854, by which time Britain had 25 years' experience with railways and a network of 6,000 miles. Most of the fighting took place in the Crimean Peninsula, which juts from the north into the Black Sea. Britain had not fought a major war since the defeat of Napoleon in 1815, and not all the generals had kept up with the advances in technology and weaponry over the last 40 years.

Underestimating the difficulties it faced and the tenacity of its enemy, the British army landed at Balaklava in autumn 1854 and then marched to besiege the fortified city of Sevastopol. Sevastopol did not surrender, and before long the Russian winter set in, a harsh season for which the British were unprepared. The journalist William Howard Russell, a pioneering foreign correspondent, sent dispatches to his London newspaper describing a chaotic situation at the battlefront, where ill-equipped soldiers were dying of cold and of cholera. He added that ships full of supplies were arriving in Balaklava, but their cargos were not being unloaded or getting to the front because so many oxen and horses had also died of disease, cold, exhaustion, and malnutrition.

Three of Britain's leading railway contractors—Samuel Peto, Thomas Brassey, and Edward Betts—offered to resolve the supply bottleneck by building a railway from Balaklava to Sevastopol, adding that they would do it at cost, making no money for themselves. Their offer was accepted, and they quickly assembled a fleet of nine ships carrying the necessary materials. It also carried the necessary men to do the tough earth shifting and plate laying. Arriving at Balaklava, they got to work and had soon built a 7-mile railway that was operated partly by locomotives, partly by a stationary steam engine pulling wagons up an inclined plane, and partly by horses.

This short line, completed in 7 weeks, transformed the situation. The supply crisis was resolved; more ammunition reached the frontline gunners, while more food, winter clothing, and shelter reached the hard-pressed soldiers. Men wounded at the front could now ride back on returning trains instead of laboring back on foot or jolting in primitive wagons.

THE AMERICAN CIVIL WAR

The first recognizably modern, railway-based war took place between 1861 and 1865: the American Civil War. Most European observers expected the Confederacy to win, at first. They did not see how the Union could hope to subdue such a vast area as the seceded Confederate states.

In its favor, though, the Union had a much more extensive railroad network than the Confederacy and used it better. Two-thirds of America's railroad mileage was in the North, linking up the major industrial cities, ports, and administrative centers. Best of all, in favor of the Union was a willingness to accept the principle of strong government. Legislation of 1862 authorized the federal government to take over the railways if necessary, and the threat, even when not carried out, made railway owners responsive to army demands.

By contrast, in the South, whose secession was based in part on opposition to centralized government, railroad managers refused to put their lines at the service of the Confederacy unless they were well paid for doing so. To make matters worse, the South's railways were heavily dependent on Northern manufacturers for rails, locomotives, carriages, and boxcars.

The Union was also able to identify, early in the conflict, two experienced men to coordinate railways' relations with the army—Daniel McCallum, a Scottish immigrant with experience in senior railroad management and bridge manufacturing, and Herman Haupt, a West Point graduate and former chief engineer of the Pennsylvania Railroad. McCallum became a colonel while Haupt kept his civilian status, but they worked well together, building new supply railways where necessary, taking over lines that were critical to the war effort, and repairing war-damaged lines.

Haupt recognized the need to keep railways running according to schedules worked out by their managers. He also grasped the vital point that the largest possible number of railroad cars must be kept in constant use and that they must not be diverted to secondary uses such as supply storage or troop accommodation.

General Sherman understood the centrality of railways to his greatest campaign. He had benefited from a well-organized buildup, including 100,000 men and 35,000 horses, all brought from the Northern states to

Chattanooga on a series of single-track railways. Crucial battles were fought around the Western and Atlantic Railroad, culminating in the Battle of Atlanta. The fighting, followed by the city's great fire, destroyed one of the Confederacy's most important logistical centers. After stockpiling supplies, Sherman ordered his soldiers to wreck the line, eliminating the danger of being attacked from behind as he began his March to the Sea.

As the war came to an end, Jefferson Davis, the Confederate president, fled Richmond by train, only to be caught and arrested in Georgia. A few weeks later, the body of President Lincoln, assassinated almost at the moment of victory, also went by train to his final resting place in Springfield, Illinois.

The Great Locomotive Chase

On April 12, 1862, Union soldiers in Georgia, led by a civilian named James Andrews, seized a train pulled by a locomotive named the *General*. Its conductor, William Fuller, commandeered a train pulled by the locomotive *Texas* and chased the *General* for 80 miles before the Union men abandoned the train. Some of the raiders were caught and hanged, and others who escaped were later awarded the Medal of Honor.

THE FRANCO-PRUSSIAN WAR

In the aftermath of the American Civil War, the Prussian commander Helmuth von Moltke and his fellow commanders studied the German translation of Daniel McCallum's 1866 report on his wartime work with the Union railways. The Prussians absorbed McCallum's principles of sound organization and implemented similar practices of their own.

Prussia was well prepared for the outbreak of war in 1870, when Chancellor Otto von Bismarck provoked France's emperor, Napoleon III, into declaring war. A wave of fervent patriotism swept over France, and its confident soldiers converged on the Paris stations. But France had not been as meticulous in its preparations as Prussia. Disputes about who controlled the railways—civilians or army officers—led to squabbles and a sharp decline in efficiency.

The Prussians besieged the frontier town of Metz, building an ad hoc narrow-gauge railway around it, 22 miles long, to supply their soldiers until the French garrison, close to starvation, surrendered en masse. Their earlier mismanagement had left 16,000 railway wagons in the city, which the

Prussians at once seized and put to use. After a decisive battlefield victory at Sedan, in which Napoleon III himself was captured, Prussia advanced into France and besieged Paris.

But the French equipment was different enough that the Prussians suffered frequent failures. The retreating French army sabotaged lines, destroyed tunnels, and blew up bridges. Even so, the Prussians were eventually able to bring heavy guns and ammunition by train and begin the bombardment of Paris that led to the war's end in January 1871 on terms that humiliated France. The French army did at least begin to recognize that, in wartime, railways must be run according to sound principles and with clear lines of authority and acknowledgment of civilian expertise.

THE BOER WAR

As the 19th century ended, Britain went to war in South Africa against the two Boer republics: the Transvaal and the Orange Free State. Expecting an easy victory, the British were thwarted by skillful adversaries. British forces in the towns of Mafeking, Kimberley, and Ladysmith were besieged, and early British attempts to relieve the sieges led to humiliating defeats. The besieged places were important, in every case, because they were railway towns.

Winston Churchill, one of the giants of 20th century history, first became a household name at this time, and two railways played a key part in his emergence as a national hero. He was riding on an armored train in November 1899 as it advanced from the little town of Estcourt in Natal toward the front lines at Colenso.

The Boer forces attacked it. Their artillery fire partially derailed the train, at once making it more of a liability than an asset and blocking the line of retreat. Churchill—despite the fact that, as a journalist and not a soldier, he ought not to have been involved in the fighting—helped the wounded train driver uncouple the derailed wagons and knock them off the line so that the remainder of the train could reverse toward Estcourt. Before this job was finished, however, he was forced to surrender at gunpoint and became a prisoner of war.

A few weeks after his capture, he jumped over the prison wall, strolled brazenly past a negligent guard, and made his way out into the countryside. Under cover of night, he jumped onto a slow-moving freight train and was later able to board another train, hide among sacks of wool, and make it across the border. His reappearance in British South Africa shortly afterward was the only bit of good news for Britain at a very bad time in the war. "I reached Durban to find myself a popular hero," he wrote later. "I was received as if I had won a great victory."

The Boer War embarrassed the British Empire, showing that it had become complacent over the last half century. The Boers' tenacity, coupled with their state-of-the-art German-made weapons, finally led the British to undertake an inhumane scorched-earth policy. They destroyed everything their enemies might use and forcibly evacuated the countryside, taking old men, women, and children by train to concentration camps, where epidemics killed them in the thousands. Building blockhouses alongside the railways, they advanced toward the Boer capital of Pretoria, capturing it in 1900 and finally forcing the last Boer holdouts to surrender in 1902.

Every new technology leads optimists to foresee a more peaceful future for the world, and railways were no exception. By the dawn of the 20th century, however, it was already painfully clear that railways had not made war a thing of the past and that they were going to intensify the pace and scale of warfare, concentrating more men and more munitions at battlefronts. But no one could yet imagine the scale of the destruction that would soon descend across Europe.

READING

Bonds, Russell. *Stealing the General: The Great Locomotive Chase and the First Medal of Honor*. Yardley, PA: Westholme Press, 2006.

Wolmar, Christian. *Engines of War: How Wars Were Won and Lost on the Railways*. New York: Public Affairs, 2010.

6

America's Transcontinental Railroads

During the American Civil War, Congress authorized construction of the first transcontinental line, designed to link California with the other states east of the Mississippi. Such an undertaking was almost certainly the single biggest engineering project in world history up to that time. This lecture looks at how the project was accomplished and the impacts it had on the country.

ESTABLISHING THE ROUTE

By the end of the American Civil War, railways already stretched as far west as Missouri and Iowa, so the first transcontinental was designed to run from Council Bluffs, Iowa, on the eastern bank of the Missouri River, to Sacramento, California. Congress authorized the creation of two companies, the Union Pacific Railroad Company, which would build westward from Council Bluffs, and the Central Pacific Railroad, which would build eastward from Sacramento. Each company was guaranteed a subsidy for every mile it completed, $16,000 on flat land and $48,000 in mountains. Each was also given grants of land adjacent to the tracks. The companies intended to sell this land to farmers, whose crops could then be shipped back to market on the railways.

The route would incorporate the easiest crossing of the Rockies, near South Pass, Wyoming, which, at 7,400 feet, was the lowest point of the Continental Divide. It could be reached on a gradual upgrade that locomotives could manage. A more daunting challenge was the Sierra Nevadas in eastern California. The route chosen went over Donner Pass, and the engineers realized that they would have to build a series of tunnels near the summit to get the railroad through the Sierras on acceptable gradients.

The mostly flat terrain in Nebraska and Wyoming was relatively easy for railroad building, so surveyors were able to create a reasonably straight route. But the plains were treeless, so wood for the railroad ties had to be brought from back East. In this era, the heavily forested states of Wisconsin and Michigan were being clear-cut for the building of railroads and for the construction of such new cities as Detroit, Chicago, Milwaukee, Minneapolis, and St. Paul.

GETTING THE JOB DONE

Half of the workers on the Union Pacific side, building from east to west, were recent Irish immigrants. The other half were former Union army soldiers, and the project was run with military discipline by Grenville Dodge, a Union army general and war hero.

Most of the workers on the Central Pacific side were Chinese immigrants, a population that had migrated to the West Coast as news of the gold rush had spread around the world in 1849. Hardworking and sober, they were attractive from the company's point of view but were bitterly resented by racially prejudiced whites.

After a relatively easy traverse of the Great Central Valley of California, the Central Pacific workers had to build a shallow-gradient track bed through the foothills of the Sierra Nevadas. It required frequent cuttings, embankments, and tunnels. Accidents were common and the death rate high. Their work and achievements are commemorated at the California State Railroad Museum in Sacramento.

The Union Pacific and Central Pacific lines finally met at Promontory Summit, Utah, north of Salt Lake City, on May 10, 1869. Leland Stanford of the Central Pacific drove a golden spike into the last wooden tie. Dignitaries traveled out on special trains for the occasion, which featured military band music, uniformed soldiers, feasting, and long speeches.

PROMONTORY SUMMIT, UTAH
MAY 10, 1869

The convergence was far from flawless. Congress had unwisely failed to specify where the two lines should meet and had rewarded the two companies for mileage completed rather than for high-quality construction. As a result, much of the workmanship was shoddy, and many sections of the line had to be repaired or even rebuilt in the ensuing years. The line operated at a serious loss at first, and much of the land it crossed in Wyoming, Utah, and Nevada was never going to be suitable for farming settlements, being too high or too dry or both.

With the completion of the transcontinental railroad, a journey from the Iowa–Nebraska border to Sacramento, which had previously required a dangerous overland trek of 5 or 6 months, could now be made in 5 or 6 days.

BUILDING TOWNS ALONG RAILWAYS

Between 1880 and 1910, the building of lines running from north to south linked the great transcontinentals together. All of them needed to encourage economic activity. In the Great Plains states, that meant persuading farmers to settle homesteads or buy land that was close to the tracks. To attract farmers, the railroads set up offices in the eastern states, offering potential buyers subsidized journeys to visit available farmland, then selling it on easy terms, with the expectation that they would recoup their investment as plains communities developed.

Some companies opened offices abroad, in Norway, Sweden, England, and Germany, luring hopeful emigrants from countries where land was impossibly expensive to a place where humble men could afford to buy farms of their own. Thousands of families emigrated in response to this publicity.

In addition to driving settlement in the American West, the transcontinental lines attracted many new forms of business. For example, in 1867, Joseph McCoy persuaded a group of cattlemen to drive herds of Texas longhorns up to Abilene, Kansas, where he built a set of stockyards adjacent to the Kansas Pacific Railroad. As they arrived, he bought the animals and arranged for their transshipment by rail to Chicago's slaughterhouses, where they were turned into meat for the growing urban workforce. Everyone profited, and cattle drives became a feature of plains life in the next 2 decades.

Also in 1867, the first refrigerated railroad car was patented, which made it possible to ship meat from Chicago to markets in the eastern cities. Chicago became the center of the nationwide meat industry, its immense stockyards handling millions of animals each year.

As plains farmers began exporting corn and wheat in greater quantities, the entire world food market altered. American farms on the Great Plains created a greater abundance than ever before and almost banished the specter of famine that had bedeviled the world for centuries. The volume of American farm production was so immense that British farmers found they could no longer compete.

In Europe and in the American East, agriculture and towns came first and railways came later. In the American West, it was the other way around: Railroads founded hundreds of towns, which then grew as emigrant families moved in and farmed the surrounding districts.

PRESSURE FOR REGULATION

Railroads clearly made the development of plains farming and ranching possible, but relations between the farmers and the railroads were rarely harmonious. The railroads often abused their power. As a line under construction approached a settlement, the directors sometimes insisted on a gift—in effect, a bribe—for them to build into the community itself. Otherwise, they would change their route to avoid it, dooming the community to irrelevance and early extinction.

Railroad companies also abused their position when it came to setting shipping rates. Farmers thought the rates were too high, especially in the 1870s, 1880s, and 1890s, when food prices were going down as the volume of food production increased. Farmers also discovered that preferential rates were given to some shippers.

By the late 1880s, western farmers' dissatisfaction was reaching a crisis point. They began to organize politically, aiming to establish national or state committees that would regulate railroad rates. The People's Party of the 1890s was an expression of this impulse. Also known as the Populist Party, it became the dominant political party in several farm states and even threatened to change the makeup of the American party system in the election of 1896. The railroads supported the major parties, especially the Republicans, against the Populists and held off the challenge, but by then they had lost the war for public opinion and were increasingly regarded as a menace.

From this context, America's first federal regulatory agency, the Interstate Commerce Commission (ICC), emerged. Founded in 1887 to discipline the railroads, the ICC could only do that job if it was well staffed to investigate all complaints and if the courts backed up its rulings. Realizing this, shrewd railroad executives did what they could to manipulate the ICC. At first, the ICC was ineffectual, but by 1910, the worst abuses were being remedied, but only through the formation of a rigid bureaucracy that would later prove destructive in a different way.

ASSESSING THE CONSEQUENCES

Most historians have viewed the transcontinental railroads as a positive force in American history. A different possibility is suggested by the Stanford historian Richard White in his book *Railroaded*. He argues that they ought not to have been built, or at least that they did not make economic sense until about 1900. There simply was not enough business in the far West, especially in the desert and mountain states, to justify their existence.

The promoters of western railways borrowed heavily, then paid out much of the money they had borrowed as dividends to shareholders to create a misleading impression of prosperity and to prevent share prices from falling. They bribed congressmen to pass favorable legislation and devoted millions each year to paying the interest on earlier debts that they could not afford to repay. They bought out newspapers to assure themselves of favorable news coverage and distributed free railroad passes to everyone of influence who could potentially help or hurt them.

White also describes the ecological disasters that the transcontinental railroads helped provoke, from the annihilation of the Great Plains buffalo herd to the destruction of land caused by overgrazing too many cattle. In addition, the railroads misled farmers to believe that it was possible to grow crops on marginal lands west of the 100th meridian of longitude. A few wet years encouraged the fallacy, but the onset of a dry period discredited that belief, leading to widespread abandonment of farms in western Kansas, Nebraska, and the Dakotas during the 1880s and 1890s.

Still, the fact remains that the transcontinental railways were built and transformed the United States, turning it into a continental two-ocean nation and contributing to its eventual emergence as a superpower. It was in the plains, deserts, and canyons of the West, moreover, that American railways took on the almost legendary aura that made them famous worldwide.

READING

Ambrose, Stephen. *Nothing Like It in the World: The Men Who Built the Transcontinental Railroad*. New York: Simon & Schuster, 2000.

Hiltzik, Michael. *Iron Empires: Robber Barons, Railroads, and the Making of Modern America*. Boston: Mariner Books / Houghton Mifflin, 2021.

White, Richard. *Railroaded: The Transcontinentals and the Making of Modern America*. New York: Norton, 2011.

7

Railways and Colonialism

The age of railways was also the era in which the European powers competed to build colonial empires throughout the world. Empires were commercial ventures for Britain, France, Germany, Spain, and Portugal, but they were also prestige projects, pursued for the sake of enhancing their mother countries' status. This lecture explores the railways built by European colonizers to strengthen their hold on colonies, to promote trade, and to warn off rivals. When these empires ended in the 20th century, they left behind a railway infrastructure on which the newly independent postcolonial nations of Asia and Africa could build.

RAILWAY BUILDING IN INDIA

Starting in the 1840s, British engineers planned and built thousands of miles of railway in India. Their motive was to strengthen Britain's grip on the subcontinent, increase its productivity, and facilitate the movement of people, goods, and soldiers across its great distances.

Lord Dalhousie was governor-general of India between 1848 and 1856, when India was still run by a monopoly trading company, the East India Company. An ardent modernizer, Dalhousie wanted to dissolve all the remaining independent states, whose kings ruled with British consent, and take over direct control in the name of good government and increased efficiency. He also sketched out a plan to link up all of India's principal towns by rail and had the satisfaction of seeing the first line open in 1853. The railway construction work was done by private companies that raised money in London but enjoyed guaranteed returns from the government.

The death rate among Indian railway builders, and among the British technical staff that organized them, was very high. Poor nutrition, inadequate housing, heat exhaustion, and epidemic diseases all took their toll, especially when the railways were crossing mountains or jungle country.

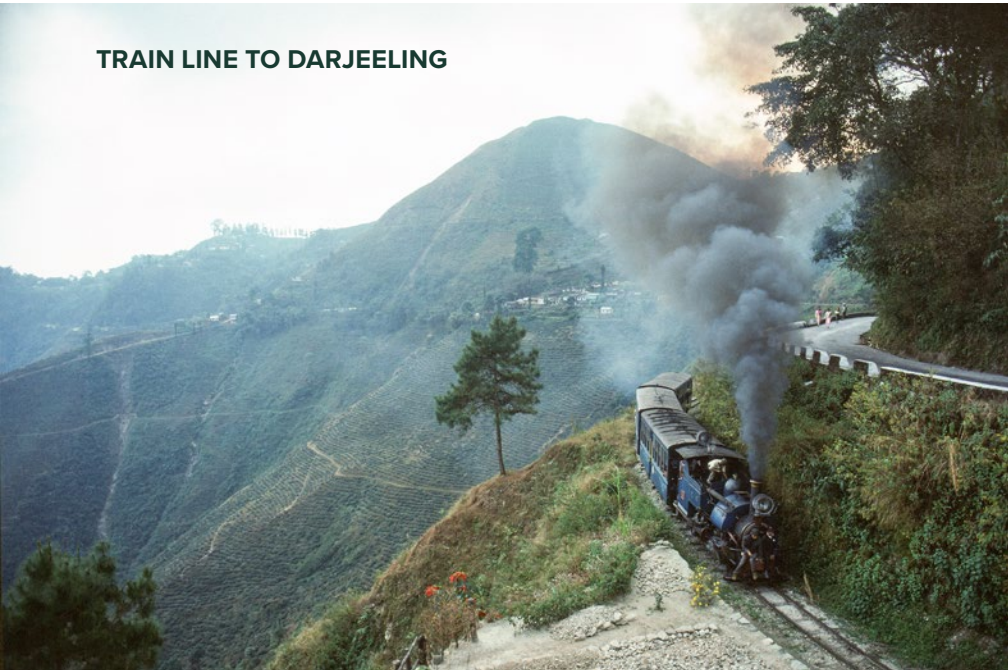
Running trains, just like building the lines, caused headaches because of India's many Hindu castes, whose members refused to mingle; because of tensions between Hindus, Muslims, and Sikhs; and because of the whites' insistence that they should not be expected to mix with the Indians.

> Early river bridges that would have sufficed in England, where the engineers had learned their trade, could not withstand the sudden increase of flow during the monsoon season, so a new set of standards had to be learned by painful trial and error.

A rebellion against the British in 1857 led to a year of brutal fighting between rebels and the British, who were aided by native regiments that had remained loyal. One of its effects was the dissolution of the East India Company and a direct British government takeover in India. Another was the decision to abandon drastic modernization programs because they led Indian leaders to fear that their religion and their traditions were under attack. Railway building, however, continued because the British saw trains as a means to carry soldiers rapidly to trouble spots.

The killing summer heat of India—especially in the big cities of Bombay, Madras, Calcutta, and Delhi—led the British to establish hill stations, whose altitude made them more temperate. Shimla and Darjeeling were the most important of these stations. The line to Darjeeling, completed in 1881, employed zigzags and spirals to gain 5,000 feet of height. It offers dazzling views of the distant snowcapped Himalayas. The line to Shimla, completed in 1903, required the building of more than 900 bridges. Both lines are now protected as UNESCO World Heritage sites.

TRAIN LINE TO DARJEELING



By 1900, India had the densest railway network in Asia, and railway work employed about 350,000 people, most of whom were Indians. Here they learned how to manage a large and complex organization that required high levels of literacy, precision, punctuality, and clear lines of authority. These qualities would also be essential to the development of India's movement for political independence in the coming century.

RAILWAY BUILDING IN AFRICA

As with India, so with Africa. Large parts of the continent were conquered by the British, partly for commercial gain and partly to safeguard its routes to India. Railway building soon followed to ship goods and to strengthen Britain's military grip against rivals and native uprisings. In 1885, for example, the forces of a militant Islamic leader, al-Mahdī, attacked a British force in Khartoum, capital of Sudan, and killed its leader, General Charles George Gordon. For a decade, al-Mahdī and his men dominated Sudan. With British government approval, however, another general, Horatio Herbert Kitchener, ordered the building of a railway from the Wādī Ḥalfā' up the Nile valley toward Khartoum beginning in 1896. The railway would carry the supplies of an army that aimed to avenge Gordon.

A talented Canadian engineer named Percy Girouard constructed the line in blistering desert heat, teaching Sudanese laborers how to do the work as he went along. Its completion in 1898 spelled the end of the Mahdist forces, who were massacred by high-powered British weapons at the Battle of Omdurman, just outside the city of Khartoum.

Among the supporters of the Sudan military railway was Cecil Rhodes, the charismatic imperial adventurer who named a large part of central southern Africa after himself—Rhodesia (the lands that today comprise Zambia and Zimbabwe). Rhodes, who made a fortune in diamonds at Kimberley, in South Africa, dreamed of a single railway that would run from the Cape of Good Hope to Cairo, crossing the whole continent of Africa from south to north. He saw the Sudan military line as one part of this great project and loaned five locomotives to Girouard to speed the project along.

Closer to his South African home base, Rhodes encouraged the construction of lines heading north from the South African coast, toward the diamond mines at Kimberley and the gold mines of Johannesburg. George Pauling, a hard-drinking but dedicated contractor, built hundreds of miles of these lines. Pauling also supervised the building of a line between Salisbury, in Rhodesia, and the East African coastal town of Beira in the face of difficulties so great they sound almost biblical. Crocodiles, hippopotamuses, and lions attacked, killed, and sometimes ate railway workers. Hundreds died of disease, and floods washed away embankments and bridges. Nevertheless, the line, begun in 1892, was finished in 1899 and revolutionized the commercial prospects of Rhodesia.

For many reasons, the Cape-to-Cairo railway was never completed. Among them, one section of East Africa stood athwart the project—the German colony in what is today Tanzania, Burundi, and Rwanda. Negotiations between the British and the Germans about railway rights through this colony failed. The Germans began railways of their own, one of which was nearly 800 miles long, linking Dar es Salaam on the coast with ports on Lake Victoria and Lake Tanganyika. Another linked the coast to the area around Mount Kilimanjaro.

Mohandas Gandhi's work against racial injustice and the British Empire began in South Africa, where, as a young lawyer, he experienced prejudice while riding a train. During World War I, he returned to India and transformed the independence campaign into a mass movement. He traveled extensively by rail, riding third class as a sign of humility but also to gather information for his indictment of British rule.

Germany's defeat in World War I delivered German East Africa into British hands as a colonial mandate. But even then, it decided not to complete the Cape-to-Cairo railway, which would have cost far more to construct and maintain than it would have returned in profits.

French empire builders dreamed of a railway from west to east in Africa, starting in the French colony of Senegal on the Atlantic coast and ending on the Indian Ocean coast of Djibouti. They rationalized their exploitation of African peoples by claiming that theirs was, above all, a civilizing mission. After two failed expeditions, France shelved the idea. During World War II, the pro-Nazi Vichy regime actually built a few miles of a desert line between Algiers and Dakar, using Jewish slave labor. None of the French projects, however, had any sound economic basis.

RAILWAY BUILDING IN CANADA AND AUSTRALIA

Canada and Australia, unlike India and Africa, were British settler colonies whose indigenous people made up only a small percentage of the population in the mid-19th century. Both faced major environmental challenges that made large parts uninhabitable. Both had concentrations of population around their eastern seaboards, much smaller western outposts, and a great empty interior.

The attempt to unify Canada's independent provinces into a new nation was embodied in the Constitution Act of 1867. The Maritime Provinces of Nova Scotia and New Brunswick, previously independent, were promised rail links to Quebec and Ontario in return for joining a united Canada, which came into existence on July 1, 1867. Canada's government owned and built these lines, which were completed by 1876, but most of the financing came from the City of London, with the backing of guarantees from the British Colonial Office.

In 1871, British Columbia, the Pacific coast province, joined Canada in return for the promise that a railway linking it to the rest of Canada would be built within 10 years. A false start, scuppered by the discovery of a bribery scandal, postponed construction until 1881, when the Canadian Pacific

Railway company finally began work. It was privately owned but heavily backed by the government, which gave it land grants of 25 million acres and subsidies of another $25 million. The work was completed in 1885, and the first passenger train from Montreal arrived in Port Moody, near Vancouver, the following summer.

As with Canada, Australia went through a process in which railway building and nation building were closely connected. The colony had begun inauspiciously, in the 1780s, as a prison camp to which British and Irish criminals were exiled. The last shipment of convicts arrived in 1868, by which time Australia had been through its own gold rush, which prompted tens of thousands of people to come voluntarily. Australia's early railway history was dogged by disagreement on the very basic question of gauge: How far apart should the two rails be? The states of Queensland, New South Wales, and Victoria each made a different choice, with the result that travelers from one state to the next were forced to change trains at each state border.

In 1901, all the eastern states united to create the Commonwealth of Australia. They offered Western Australia the chance to join in exchange for a railway, and the offer was accepted. The line, which was built between 1912 and 1917 across the great Nullarbor Plain, includes the longest straight stretch of railway in the world, 297 miles without a curve. The railway was as successful at turning Australia into a single nation as it had been in Canada.

Historians continue to disagree about the rights and wrongs of the Europeans' colonial empires. No one now accepts at face the value the old justification that they were instruments of civilization, designed to bring peace, prosperity, and Christianity to pagans and barbarians. However, most agree that some empires were worse than others. Most historians also agree that some colonial ventures had the effect, if not the intention, of nurturing a sense of nationhood and building a vital infrastructure. Railways rank high on this list of benefits.

READING

Day, John. *Railways of Southern Africa*. London: Arthur Barker, 1963.

Srinivasan, Roopa, Manish Tiwari, and Sandeep Silas, eds. *Our Indian Railway*. N.p.: Cambridge University Press, 2006.

Wolmar, Christian. *Railways and the Raj: How the Age of Steam Transformed India*. London: Atlantic Books, 2017.

8

Mountain Railways

Railways run best on level ground, so early builders modified the landscape to keep the track bed as flat as possible. But when it came to mountainous terrain, engineers were often forced to work out ways of getting their railways to navigate steep gradients. This lecture showcases the fascinating array of solutions they designed—from tunnels and bridges to spirals and zigzags—which are great to see and even better to ride on.

TECHNIQUES FOR GAINING ALTITUDE

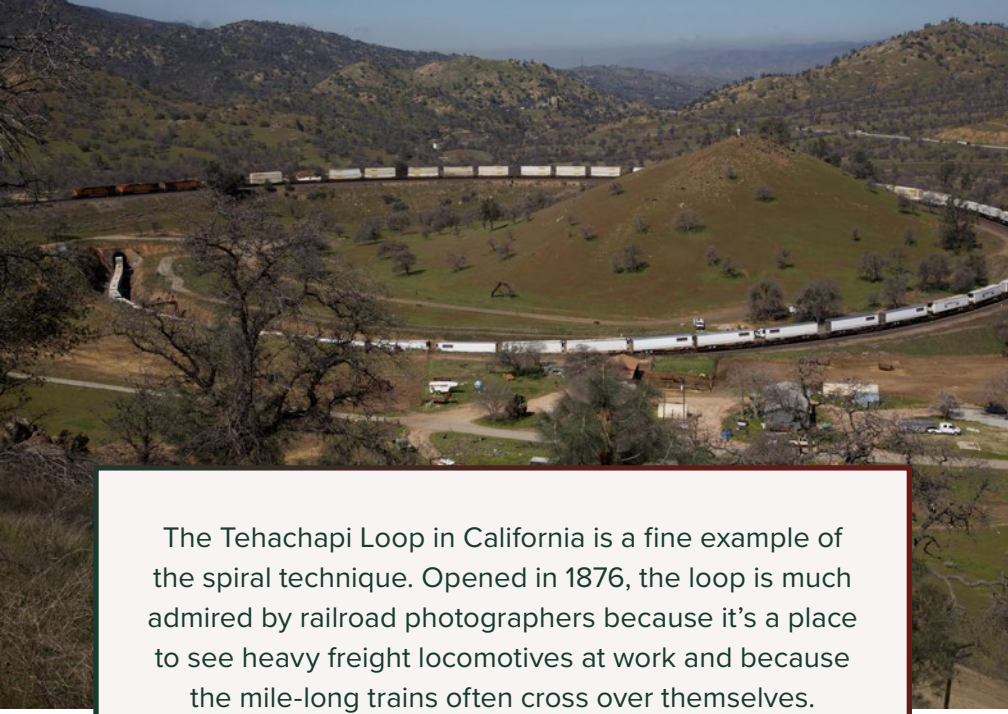
The primitive wagonways of the English mining districts were built to get coal wagons from the mines to nearby waterways, which often meant going steeply downhill. Many early builders experimented with rails on inclined planes, down which wagons were lowered by rope. Early steam railways used them, too.

For longer routes, railway surveyors found the shallowest possible way through mountain terrain, sometimes creating a twisting indirect line that meant more miles but a viable grade all the way. They built tunnels through the steepest hills and mountains, a task that increased the cost per mile, the number of workers required, and the danger. The history of tunnel building is punctuated by disaster and heartbreak. The sheer labor required to hack a tunnel through solid rock in the days before modern explosives is difficult to imagine.

High bridges over valleys and canyons were equally characteristic of mountain railways. Built first of wood, which was vulnerable to rotting and fire, most bridges were eventually replaced with metal trestles that can still be admired today. One of the great metal bridges of the 19th century is the Garabit Viaduct, in the Massif Central mountains of France, built in the early 1880s. Designed by Gustave Eiffel, its exhilarating main arch is 540 feet across and stands 400 feet above the river—in its day, it was the highest arched bridge in the world. The viaduct is still in use today, though the trains now edge across it at just 10 mph.

Another technique was the spiral, in which a combination of bridges and embankments enabled the track to cross over itself. This technique kept the gradient shallow enough that the line could be used by heavy freight trains.

The zigzag approach requires the train to move diagonally across the mountainside and onto a succession of long sidings. Then the points are shifted, and the train moves up in the opposite direction along a second track and into another long siding. A series of these zigzags enables it to gain height up a slope that would otherwise be too steep, but it's a slow process that requires a lot of tracks and means that the trains have to be relatively short. There is a working zigzag on the Roaring Camp Railroad in Felton, California, but to see the greatest examples still in use, one has to go to Darjeeling in India or to the Lithgow Zig Zag in Australia.



The Tehachapi Loop in California is a fine example of the spiral technique. Opened in 1876, the loop is much admired by railroad photographers because it's a place to see heavy freight locomotives at work and because the mile-long trains often cross over themselves.

Tunnels, spirals, and zigzags were built to accommodate conventional trains. The alternative was to build a rack-and-pinion railway, in which a central third rail—toothed to engage a rotating cog wheel—is added between the smooth rails. Rack-and-pinion railways enable trains to ascend steeper gradients. They are slower, noisier, and less fuel efficient, but in many places, they are the only solution.

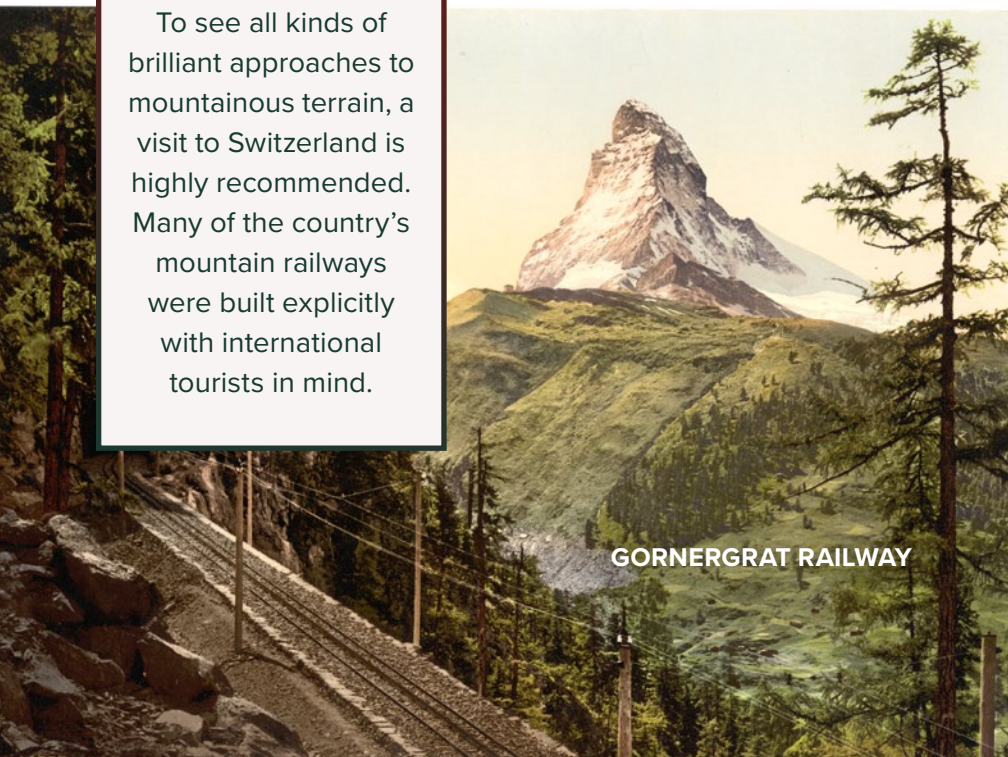
The world's first rack-and-pinion railway opened in 1812 between the towns of Middleton and Leeds in England, and the original machinery, designed by John Blenkinsop, can be seen at the Shildon annex of the British Railway Museum. The first rack-and-pinion railway in America was built by Sylvester Marsh, a Yankee inventor who had a vision for a train that could climb New Hampshire's Mount Washington, the highest mountain in the northeastern states. The line opened all the way to the summit in 1869, and the Mount Washington Cog Railway is still going strong today.

SWITZERLAND'S MOUNTAIN RAILWAYS

Switzerland's fortunes took an astounding turn for the better in the 19th century when visitors from other parts of Europe, particularly Britain, decided that mountains were not ugly and threatening but sublimely beautiful. First the Romantic poets, including William Wordsworth, Samuel Taylor Coleridge, and Lord Byron, rhapsodized over the mountain landscape, then mountaineers began to visit.

One line runs from Zweisimmen to Montreux. Zweisimmen is a pretty rural town whose picture-perfect timbered train station includes a decorative wooden spire. The panorama train to Montreux, with its plate glass windows, climbs steadily as it leaves town, up to a high-altitude route across high flower-strewn meadows.

To see all kinds of brilliant approaches to mountainous terrain, a visit to Switzerland is highly recommended. Many of the country's mountain railways were built explicitly with international tourists in mind.



GORNERGRAT RAILWAY

The descent to Montreux is precipitous and excitingly steep. Montreux itself, on the northern shore of Lake Geneva, is a gem. The Château de Chillon, one of the most romantic castles in Europe, is just a short walk from the station.

Among Switzerland's most popular tourist destinations today is the Jungfraujoch—a saddle between two immense peaks that are snow-covered all year round: the Jungfrau and the Mönch. Along with these two mountains, a third peak, the Eiger, towers over the Swiss village of Grindelwald. The Jungfrau Railway runs into the heights of these peaks, and at 11,300 feet, the Jungfraujoch station is the highest railway station in Europe.

Even approaching this range of the Alps is a thrill. The train from Zürich to Interlaken weaves among ever-higher mountains, many of which are snowcapped throughout the year. It then runs along the shore of Lake Brienz. From Interlaken, narrow-gauge trains wind their way up the valley to Grindelwald. They require tight turns, high bridges, and several sections of rack-and-pinion track, of which passengers are instantly made aware. The train slows to a crawl, the normally silent running is replaced by a low grinding sound, and the grade suddenly intensifies as passengers are carried up much more rapidly than an ordinary train could manage. The wheels sometimes shriek on the steep curves.

From Grindelwald, travelers can take a cable car, the Eiger Express, up to a junction point called Eigergletscher. From there, a rack-and-pinion train carries them up to the top of the mountain. The only drawback is that for this part of the journey, passengers are inside the mountain, so there is nothing to see. The line's builder, Adolf Guyer-Zeller, realized that the severity of the terrain and the weather made tunneling inside the mountain his only option. The work began in 1896 and was finished in 1912. A luxurious complex of restaurants, bars, and shops is built into the mountainside. There's also an astronomical observatory built on a striking rock pinnacle.

Another line, the Gornergrat Railway, began service in 1898 and gains more than 5,000 feet, ending on the peak of the Gornergrat, at about 10,150 feet above sea level. It rises out of another steep valley, from the bustling little resort town of Zermatt, near the Italian border. Zermatt's chief claim to fame is its proximity to the world's most instantly recognizable mountain, the Matterhorn.

The advantage of the Gornergrat train over the one that takes passengers to the Jungfraujoch is that it's nearly all out in the open. The gradient is intense, and the line is equipped with a double rack and pinion for extra traction and a double overhead electric pantograph to bring as much power to the locomotives as possible. The station at the top is built in the style of an old castle. Here the observation platform discloses an otherworldly scene of rock, glittering ice, and mountaintops, 29 of which rise above 13,000 feet.

A third Swiss wonder is the Bernina Railway in southeastern Switzerland, a line that was built so ingeniously that the engineers were able to avoid using rack-and-pinion sections despite crossing a series of steep mountains. It was opened in 1908, and on its 100th birthday, a 120-kilometer section of it was named a UNESCO World Heritage site. Electrified right from the start, it has tight horseshoe bends that help it zigzag up the steepest slopes. At one point, it makes a 360° spiral turn inside a tunnel. Near the summit stand two lakes, backed up behind dams that the railway construction company had to build to generate enough hydroelectric power.

At one point, there's another spiral which, unlike the earlier tunnel, is right out in the open. Passengers descend toward a viaduct, the train glides onto it, turning right sharply and crossing the bridge. It then takes a continuing hard right turn so that, a moment later, it has made a complete circle and travels under the bridge that it had traveled over a few seconds before. This is the Brusio spiral viaduct, which was created to reduce altitude and to bring the line off the side of the valley and onto its floor.

FUNICULAR AND HYBRID RAILWAYS

Funicular railways are a subgroup of cable trains that can rise on gradients at or even above 45°. The cars themselves are usually built with tiered seats and compartments, enabling everyone to look down on the landscape while rising sharply away from it or hurrying to meet it.

In Lugano, part of Switzerland's Italian-speaking canton of Ticino, the first funicular passengers come to, arriving in Lugano by train, takes them from the station down into the picturesque narrow streets of the old town. It neatly sidesteps the other train coming up from the bottom. Much larger are the

Monte Brè Funicular and the one at Monte San Salvatore. The San Salvatore was built in the 1890s when railway construction and the holiday business were booming symbiotically.

From the top of San Salvatore on a clear day, it's possible to see 50 miles in every direction. A small museum also describes the history of the funicular and the development of Lugano as a resort. The decisive event in this process was the building of the St. Gotthard Tunnel, which was opened with great fanfare in 1882.

Switzerland's neighbor, Austria, is equally mountainous and has outstanding mountain railways of its own. From the city of Innsbruck, for example, it's possible to take the Hungerburgbahn, a hybrid railway that takes one to a mountaintop overlooking the city. The lower part, featuring ultramodernistic stations, is a cable car that runs on the same system as the San Francisco streetcars. The ingenious cars of each train are connected inside a steel frame, but each one adapts to the gradient, remaining upright even as the train climbs steeply after crossing the Inn River. Halfway up the mountain, passengers transfer into an overhead cable car to reach the summit, snow-covered for 10 months of the year and a gaunt rockscape in midsummer.

READING

Bewes, Diccon. *Slow Train to Switzerland*. Boston: Nicholas Brealey, 2014.

Heald, Bruce D. *The Mount Washington Cog Railway: Climbing the White Mountains of New Hampshire*. Charleston, SC: The History Press, 2011.

9

The Invention of Tourism

For centuries, travel was difficult, dangerous, and expensive. Hardly anyone thought of traveling for pleasure. Now, millions of people travel long distances every year to see different parts of their own country and other parts of the world. Called tourism, it's one of the biggest industries on the planet. For many countries, tourism is the single largest source of employment. As with so many other characteristics of contemporary life, it's largely an invention of the railways. This lecture looks at some of the early leaders of the industry and the hot spots people traveled to see.

EARLY TRAVEL AGENTS AND ACCOMMODATIONS

When the directors of the Liverpool and Manchester Railway opened their line in 1830, they were pleasantly surprised to find that there was as much demand for travel from passengers as for freight. But if prosperous people were traveling for pleasure, they needed suitable places to stay. Railway companies played a leading role in building high-quality hotels at the major stations, often incorporating them into the fabric of the station itself. The Great Western Royal Hotel at Paddington Station and the Midland Grand Hotel at St. Pancras are two good examples in London, while the North British Hotel in Edinburgh—still a dominant presence on the skyline—is their Scottish rival. These hotels were grander and more luxurious than the coaching inns that fell into obscurity as trains displaced stagecoaches. They also helped establish the custom of upper-middle-class people dining in public at a time when restaurants were few and far between.

Thomas Cook was the first person to establish a business arranging travel for others. Born in 1808, Cook was in his twenties when the first railways were being built across England. A young Baptist, he had taken the temperance pledge. His first venture into the travel business was to arrange, in 1841, for a group of Leicester teetotalers to attend an abstinence rally in the nearby town of Loughborough. A skillful negotiator, Cook was able to persuade the railway company to offer a bulk-rate discount. The outing was a success and led him to develop the new profession of travel agent.

Moving to London in 1865, Cook opened a shop for travelers. In addition to clothes, suitcases, and even telescopes, Cook also sold books of vouchers to travelers, which they could redeem for food or lodgings at places all over Europe that were on his list.

Karl Baedeker, a vital figure in the development of tourism, introduced the idea of giving stars to denote quality to restaurants, hotels, and sights.

Cook's contemporary in Germany was Karl Baedeker, a bookseller from Koblenz. Baedeker pioneered the publication of high-quality guides for tourists in 1832. They included maps; described transport, accommodation, and restaurants; gave recommendations about what to see and where to walk; and offered summaries of local customs, useful phrases, and accurate prices that visitors could expect to pay, along with prevailing exchange rates.

American tourism also became a mass phenomenon with the development of railways. Completion of the Erie Canal in 1825 made it easier for East Coast residents to reach Niagara Falls, which was already famous as one of the great wonders of nature. Completion of a railway to Niagara Falls in 1840 made it much easier, after which the little town never looked back. Niagara Falls had the densest concentration of hotels anywhere in America by 1870, along with a variety of attractions. In the 1890s, 92 passenger trains stopped at Niagara Falls every summer day. It was the single best-known American attraction to visitors coming from Europe.

In the years after the American Civil War, tourists also began to visit cities, encouraged by the World's Columbian Exposition of 1893 in Chicago and by the first Baedeker guide to America, which also appeared that year. It described the attractions of New Orleans, Washington, Chicago, and other cities in detail and compared European and American trains.

One chronic complaint about American train travel was the poor quality of the food available on most trains and in most stations. Another vital figure in the development of tourism was Fred Harvey, who resolved to do something about it. Born poor in London, he emigrated to the United States and gradually worked his way up in the hotel industry to management positions. In 1876, he began a long and successful relationship with the Santa Fe Railroad, which by 1887, reached all the way to Los Angeles.

Harvey set about establishing good-quality restaurants along the Santa Fe tracks. The Harvey Houses were, in effect, America's first restaurant chain, in which repeat customers knew what to expect and that it would live up to their expectations.

Harvey also pioneered the printing of picture postcards, enabling travelers to send home photographs of the scenic places they had visited. He promoted such places as the Pueblo Indian village of Taos, New Mexico, and the Grand Canyon. He arranged with the Santa Fe Railroad to pause its cross-country trains at Williams, Arizona, so that passengers could travel to the rim of the canyon to see it in the dramatic light of dawn and sunset.

In 1901, building further on his idea, the Santa Fe laid the tracks for a spur line to the edge of the canyon, which was followed by the construction of the El Tovar, a luxurious hotel in rustic style, right on the brink of the canyon itself. In 1908, Roosevelt designated the canyon a national monument, and it became a national park in 1919. This sequence of events could not have happened without the Santa Fe's initiative.

SUMMER AND WINTER DESTINATIONS

Far to the north, James J. Hill finished the Great Northern Railway between St. Paul, Minnesota, and Seattle, Washington, in 1893. His son Louis promoted Glacier National Park as America's answer to the Alps and worked to attract tourists to the area. The hotel he established there in 1915, the Many Glacier Hotel, was built in the style of a Swiss chalet. The nearby Glacier Park Lodge was also built by a subsidiary of the Great Northern.

Tourism to Glacier National Park was seasonal—summer only. Another railway-inspired initiative was in Florida, this time for winter tourists. Florida, bought from Spain by the Transcontinental Treaty of 1819, was a swampy malarial wilderness for most of the 19th century and inaccessible by rail south of Jacksonville, which stands close to the Georgia state line. Henry Flagler, an oil millionaire, moved from New York to Jacksonville, Florida, in the early 1880s seeking a healthier climate for his sick wife. Mrs. Flagler died, but Henry Flagler began to develop the area's possibilities. He built a rail line from Jacksonville south to St. Augustine and a grand hotel, the Ponce de Leon, at its terminus. It attracted elite New Yorkers looking to enjoy the benign winter climate. He extended the line down to Palm Beach, where he set up more lavish hotels, eventually running the line all the way to Miami in 1896.

His final project, completed in 1912, the year before his death, was a railway from Miami to Key West, most of which had to be built across the shallow waters of the Gulf of Mexico, linking a chain of low islands with a succession of spectacular bridges. He named it the Florida Overseas Railroad. However, the line never made a profit, and it came to a dramatic end in 1935 when, on Labor Day, a hurricane destroyed 40 miles of track and swallowed up a rescue train. The railroad, already close to bankruptcy, was unable to recover from this blow and sold its assets to the state. Today, some of its structures have been incorporated into Route 1, the road to Key West. Other sections are visible from the road, and the whole thing is protected through a listing on the National Register of Historic Places.

A different kind of railroad tourism catered to Americans' morbid fascination with train crashes. Between the 1890s and the 1930s, numerous state fairs featured staged train crashes, often with enormous audiences willing to pay for the spectacle.

TRAIN RIDES AS A CRUISE

One of the conceptual breakthroughs of late 20th-century tourism was the realization that slowness can be a virtue. For example, oceangoing ships were at a fatal disadvantage for Atlantic crossings once regular jet service was established in the 1950s, and the doom of the great liners seemed assured. But the shipping industry was able to embrace the idea of the ocean cruise, in which the whole point was to relax and savor the experience. Coupled with rhetoric about the threats to health posed by the hectic way of modern life, cruises even promised therapeutic benefits.

The same thing happened with trains, especially those that could get to remote and beautiful places while taking all responsibility out of the travelers' hands and giving them plenty of rich food along the way.

Representative of this trend is the *Glacier Express* in Switzerland, whose artful motto is "The Slowest Express Train in the World." It crosses the country from Zermatt in the southwest to St. Moritz in the east, an 8-hour journey on winding mountainous narrow-gauge lines where high speeds are impossible. The train dodges in and out of tunnels and avalanche shelters along most of the route and crosses spectacular bridges. Throughout the journey, attentive waiters serve coffee, schnapps, a lavish lunch, and extra snacks, pampering the passengers in a way that's reminiscent of life on a cruise ship.

In Norway, passengers from actual cruise ships can take a shore excursion on the Flåm Railway, which links the head of the Sognefjord to the main line between Oslo and Bergen. Built in the 1920s and 1930s, it enabled travelers to descend from an altitude of about 2,500 feet to sea level in about 15 miles. Today, most travelers do it the other way round, temporarily leaving their ships after sailing along the fjord then taking the train up to the main line. The highlight of the trip is a stop to see a spectacular waterfall, Kjosfossen.

On the Mediterranean island of Majorca, the coastal towns are dense with big hotels, bars, restaurants, and nightclubs. But just a few miles inland, one regains a sense of what the island must have looked like for centuries: rocky, terraced, and dotted with vineyards and olive groves. An old wooden train, the *Ferrocarril de Sóller*, built in about 1910 and originally designed to ship oranges and lemons from farms in the hills to the coast, is now dedicated mainly to tourists. It winds through woodland and into the rocky hills, through tunnels and over bridges, to the attractive town of Sóller.

These three trips, in Switzerland, Norway, and Spain, are all short enough to be experienced in a day. If you're looking for something on a grander scale, go to Australia, Canada, or the western United States, where it's possible, at a price, to have lavish vacation trips that last for days. No matter the type of trip, railway tourism is a great reminder of how trains, by revolutionizing travel, also radically altered the way humans experience the world.

READING

Fried, Stephen. *Appetite for America: Fred Harvey and the Business of Civilizing the West, One Meal at a Time*. New York: Bantam, 2011.

Standiford, Les. *Last Train to Paradise*. New York: Crown, 2003.

Zuelow, Eric. *A History of Modern Tourism*. N.p.: Red Globe Press, 2015.

10

Railway Workers and Unions

Apart from agriculture, railroads were the biggest employer of their age. Employees needed to be skilled if the trains were to run on time, operate safely, and deliver goods to the right place at the right time. Railway companies tried to promote harmony between workers and their employers. Sometimes they succeeded, but many railway workers faced unsafe working conditions, low wages, tyrannical discipline, and the threat of arbitrary dismissal. This lecture examines the efforts of workers to form labor unions to address these issues and others.

EARLY WORKING CONDITIONS

Working on early railways was dangerous, especially for the first generation of workers who had no experienced elders to learn from. Trains were faster than any earlier vehicles. As their speeds increased, so did the danger that they would run out of control, derail, and kill people. Drivers and firemen on open footplates had to endure intense winter cold and summer heat with little protection. Inadequate brakes in the early days meant that brakemen had to run along the top of trains, cranking brake wheels on each individual car when they needed to stop. Brakemen were often jolted off their trains on sharp curves or knocked off by bridge parapets. The death rate among them was high.

Switchmen, the workers who coupled locomotives and wagons together in freight yards, often lost fingers or hands when the trains moved unexpectedly. Imperfect signaling systems and bad weather led to collisions, and when trains crashed, splintered wooden rolling stock was vulnerable to fire.

Early railway managers in Britain were often former army officers, used to imposing discipline on their subordinates. Employers took the view that their workers were, in effect, always on call and could be required to work through the night or on holidays.

The year-round work offered by railways meant that workers did not face seasonal periods of unemployment or underemployment, which was characteristic of farm work. Many railway workers saw their jobs as the nearest they could get to lifelong job security. Railways on both sides of the Atlantic introduced the idea of the career path, whereby loyal employees could expect steady promotion through the years.

Where America had a tradition of at least rhetorical equality across the social classes, Britain had a long heritage of social class distinctions that were still strongly felt and often poisoned relations in the workplace.

Managers, a higher class of employees, faced their own challenges. Railways were extremely expensive to build and run. To recoup their investment, owners needed to keep them in operation throughout the year, whatever the weather, if they were to build a reputation for reliability. Owners also had to trust managers to perform conscientiously, even when they were too far away to watch. If relations between management and workers deteriorated, the railways' assets were vulnerable to sabotage. Managers, usually referred to in Britain as officers, were sometimes caught in a vice between the need to please the owners and the need not to alienate the workers.

EARLY TRADE UNIONS

The first railway workers' trade unions were "friendly societies," made up of men in the same job who gathered together sociably but also contributed regularly to funds that would help sick or injured members and their families. Gradually, they started to organize around work issues. Unions function best when their members are skilled because they cannot easily be replaced if they go on strike. Their skill gives them bargaining power with their employer, who cannot afford to lose them.

Creating trade unions was not easy. First, they faced political opposition from governments that sympathized openly with capitalism and saw organized labor as a threat. Railways, after all, grew up in the age of Karl Marx and militant socialism. Second, governments often regarded railways not simply as one among many industries but as a special case since they could hold the welfare of the entire nation in their hands.

Third, employers would single out leaders among union organizers, fire them, and share blacklists with one another to prevent those leaders from getting railway work elsewhere. Fourth, employers knew that they could often starve strikers into submission because it was so difficult for unions to accumulate enough funds to support a long strike. Fifth, unions were most effective if they could achieve universal membership and unanimous action. That was never going to be easy because strong personalities tended to emerge within unions and come into conflict with each other.

Unions on both sides of the Atlantic struggled to get recognition from the railway companies. The companies did everything they could not to acknowledge the unions' right to bargain on behalf of employees, fearing that recognition would be a foot in the door and that their control over their own industry would diminish.

THE GREAT RAILROAD STRIKE OF 1877

The American economy had gone into a sharp contraction in 1873, with bankruptcies leading to widespread unemployment. In 1877, the Baltimore and Ohio Railroad followed most of the other major lines by cutting its employees' pay. By then, many railroad companies were regarded as bullies, charging excessive fares and freight rates and risking people's lives with unsafe operating practices.

The 1877 strike began when workers whose pay had been cut refused to let trains leave Martinsburg, West Virginia. The local militia were sent, but many militiamen sympathized with the strikers, and the effort to disperse them failed. Officials of the Baltimore and Ohio Railroad flatly refused to negotiate with the strike leaders, relying instead on the expectations that their own side of the dispute would receive government help and that they could use strikebreakers to get the trains going again.

When National Guardsmen attacked strikers in Pittsburgh, killing as many as 20 people, including women and children, the strikers retaliated. They poured oil over the coal in a railroad car, set it on fire, and rammed it into the locomotive roundhouse, where the guardsmen had taken cover. The guardsmen fought their way out of the burning building by firing rifle volleys, killing about 20 more people and suffering casualties of their own.

More than 1,000 freight cars and 100 locomotives caught fire. A similar scene led to large-scale fires in Philadelphia, which burned down much of the central city. Soldiers and strikers fought pitched battles in the streets of Baltimore, too. With the help of federal troops, the national strike was finally suppressed after 45 days.

The 1877 unrest left more than 100 people dead and an ugly legacy of bitterness between labor and management.

THE PULLMAN STRIKE OF 1894

George Pullman had made a fortune building luxurious railroad coaches that included sleeping compartments and restaurants for first-class passengers. He provided houses for his workers in a company town just outside Chicago that was named after him: Pullman, Illinois. In the economic depression of the 1890s, however, he cut his workers' pay without reducing their rents and reduced his workforce from 5,500 to 3,300. Workers who lost their jobs also lost their housing.

Meanwhile, a new union, the American Railway Union (ARU), had been forming under the leadership of a former locomotive fireman named Eugene Debs. Debs designed the ARU to overcome the weakness of fragmented unions within the industry. He supported the Pullman workers when they voted to strike. He urged ARU members to avoid violence, but a confrontation with National Guardsmen soon led to angry clashes and street fighting. The governor of Illinois, John Altgeld, believed the strike was justified and urged Pullman to conciliate. Once again, the intervention of federal troops defeated the strike, at the cost of many civilian lives.

Pullman, Illinois, is now a national monument. The clock tower and administration building make up the visitor center, and another museum nearby explains the history of the company town, the strike, and the paradoxical reputation of Pullman himself, who died about 3 years after the end of the strike.

THE FOUNDING OF BRITAIN'S LABOUR PARTY

Railway unionism was as important in Britain as in America and played a key part in the development of the Labour Party. At first, the union movement was mild and moderate. The Amalgamated Society of Railway Servants, founded in 1872, declared that its objectives were to promote understanding between labor and management, achieve a 10-hour workday, arbitrate disputes, prevent strikes, get overtime pay for Sunday and holiday work, and win pensions for retired members.

In 1900, workers for the Taff Vale Railway Company went on strike over issues of pay and union recognition. The company retaliated by suing the union for the losses it sustained during the strike. To the workers' horror, the court found in favor of the company, and then the House of Lords, acting as a supreme court, upheld the verdict. In effect, this decision nullified all British unions' ability to strike by making them liable to payment of ruinous expenses while sheltering their employers from economic consequences.

In the years leading up to this decision, British trade unionists had been debating whether to create a political party to represent their views or whether to concentrate directly on questions of pay, safety, hours, and conditions. The verdict of the *Taff Vale* case tipped the scales toward the political solution. It led unions and socialists to create the Labour Representation Committee in 1900—in effect, this was the founding of the Labour Party. Its members declared their intention to pursue direct political action, specifically the reversal of the *Taff Vale* decision.

In the election of 1906, Labour won 29 seats in Parliament. The Liberal Party had an overall majority in the House of Commons, but its leader, Prime Minister Henry Campbell-Bannerman, could foresee that the rise of Labour was likely to spell the end of the Liberal Party. Therefore, he supported passage of the Trades Disputes Act of 1906, which nullified the *Taff Vale* decision. From then on, the unions' right to strike without fear of financial liability was assured.

Obdurate British railway companies still refused to give official recognition to the unions. Under intense political pressure, they agreed to create a conciliation board in 1907 that would arbitrate disputes between labor and management, but they used this system to bury workers' complaints in slow-moving bureaucratic investigations. This situation led to a general railway workers' strike on August 16, 1911. Soldiers, police, and strikers fought pitched battles in many towns across England and Wales.

The strike was highly effective, forcing the Liberal government to take drastic steps, one of which was to compel the railway companies to give official recognition to the unions. After just 2 days, the government and the companies capitulated. From then on, the railway unions were fully recognized. They gained further strength in 1913 when three of the four unions consolidated into the National Union of Railwaymen.

READING

Case, Theresa. *The Great Southwest Railroad Strike*. College Station: Texas A&M University Press, 2010.

Kelly, Jack. *Edge of Anarchy: The Railroad Barons, the Gilded Age, and the Greatest Labor Uprising in America*. New York: St. Martin's Press, 2018.

11

Urban Railways above and below Ground

As cities grew rapidly in the late 19th century, they sought an efficient way of moving people from their homes to the places where they worked. Street railways were the answer. Drawn by horses at first, street railways began switching to electrical power around 1890. By then, they were being supplemented by underground railways, which had caught on widely, starting with London in the 1860s. This lecture explores the fascinating evolution of city railways around the world.

EARLY STREETCARS

Horse-drawn streetcars could carry heavier loads than horse-drawn buses, but they faced two problems. The first was the tendency to overwork the horses by overloading the cars. The second problem was a severe epidemic that afflicted America's urban horses in 1872, bringing entire cities to a standstill and forcing their citizens to realize the extent of their reliance on these vulnerable animals.

The development of practical electric motors by Frank Sprague and others in the 1880s enabled streetcar systems to replace their horses with faster, cleaner, and more powerful electric vehicles. Sprague installed the first electric streetcar system in Richmond, Virginia, in 1888. The cars drew power from overhead cables through a spring-loaded wand.

Streetcars played an important role not just in carrying people around areas that were already built up but also in helping cities expand. Enterprising streetcar companies often built lines out into the surrounding countryside, after buying up much of the land along their routes ahead of time. Then, as suburbs developed along these new lines, the railways profited from the rapid increase in real estate values.

A variant on the electric streetcar was the San Francisco cable car, now one of the city's instantly recognizable symbols. The first cars ran in 1873. Andrew Smith Hallidie, an immigrant from England, invented it after being horrified at the sight of horses falling and being injured on one of San Francisco's steeply sloping streets. Wire cables, which were far stronger than ropes of the same diameter, were the key to his new design.

Unlike an electric streetcar, which has its own engine powered by electricity from overhead wires, the San Francisco system relies on a moving cable that is just below street level, onto which the car can be attached by a gripping mechanism controlled from inside, relaxing its hold as necessary when the car needs to stop. The Cable Car Museum on Mason Street in San Francisco is also the enginehouse. There one can see the massive rotating wheels around which the cables are wound and that keep the whole system in motion.

Streetcars, or trams, as they were called in Britain, had three drawbacks. First, they got caught up in heavy traffic. Second, they were confined to the rails and could not pull up to the curb, creating a risk for people climbing on and off. Third, railway tracks embedded in the streets were a hazard to cyclists, whose wheels could get stuck in them and cause accidents. Underground railways sidestepped all three problems.

UNDERGROUND RAILWAYS

The world's first underground railway, the Metropolitan line, was built in London and opened in 1863. It followed the route of surface streets. Navvies built trenches to a depth of about 25 feet, laid rails, and then roofed over the trenches to restore the roadway. This technique, known as cut and cover, was effective so long as the railway was close to the surface. The Metropolitan line linked several of the major London stations: Paddington, Euston, St. Pancras, King's Cross, and Fenchurch Street. Its great drawback at first was the choking smoke that its locomotives produced, nauseating and sometimes almost asphyxiating passengers.

Deeper tunnels demanded a more sophisticated approach. Earlier in the 1800s, Isamard Kingdom Brunel and his father had built a tunnel under the Thames River using a patented drilling platform (the tunnelling shield). Completed in 1842, the tunnel did not carry a railway and was used solely by pedestrians. Later improvements in drilling technology, especially a machine called the Greathead shield, enabled underground "tubes," or tunnels, to be driven more quickly and at greater depths. James Greathead, its inventor, built a second tunnel under the Thames in just 1 year (whereas the Brunel project had taken 17), fortifying it with a cast-iron surround. His basic design is still in use today, adaptable to a variety of ground conditions, including earth, clay, and hard rock.

London's underground trains shifted from steam to electricity in the 1890s despite the high cost of conversion. The trains drew electricity from a third rail. A metal contact plate, or shoe, attached to the train, ran along it. Air quality in the tunnels improved immediately. The London Underground was a huge success and has remained so ever since. Experiments with different classes of travel were soon abandoned, making the Underground one of relatively few sites of democratic sharing among class-conscious Britons.

The building of each subsequent line of the London Underground presented new challenges. As a result, a fund of experience and expertise developed, along with a set of best practices for drilling safely and accurately. However, so many other things were now under the streets—drains and sewers; water, gas, and electricity conduits; and the older underground tubes—that new lines had to be built at ever-

Harry Beck, a London Underground employee, designed the famous Tube map in 1931 that, with minor modifications, has been in use ever since. Beck simplified earlier maps and gave each of the lines its own color. The map was so useful that almost every other underground system in the world has adopted its principles.

lower depths. As with American streetcars, so with the London Underground; it stimulated the growth of suburbs ever farther from the city center. On most lines, the rails emerged from tunnels into the open air once they left central London. More than half of the London Underground's total mileage today runs above ground.

Other cities around the world soon followed London's example and built their own underground railways. The first in Europe was in Budapest, which opened in 1896, followed by Paris in 1900.

The first American underground was the "T" in Boston. It opened in 1897 despite widespread opposition from people who associated going under the ground with death and burial. Their fears were underlined by the fact that its construction required digging up an old graveyard and exhuming the bodies for reburial elsewhere.

New York's first subway line opened in 1904, by which time the city had nearly 40 years' experience with elevated railways along its main avenues. The first line ran from City Hall Park, near the tip of Manhattan Island, to 145th Street and included four tracks, which enabled express trains, stopping at only a few of the stations, to run past slower trains that visited every station. It opened at a time when two of the great pioneers of electricity, Thomas Edison and George Westinghouse, were sparring over the question of which was better and safer: direct current or alternating current. The New York subway adopted direct current and built its own power station, an immense structure on 59th street. Today, the New York Transit Museum is housed in an abandoned station and contains representative trains from each era of the last 120 years.

Paris, London, New York, and Boston were all thrown into the shade by the magnificence of the Moscow subway, built in the 1930s as a Soviet prestige project. The strangeness of it was that it was built during a time when mass executions were occurring and when most Soviet citizens were enduring extremely low standards of living. Among the gems of this splendid subway system is Komsomolskaya station, whose bronze and yellow ceilings, great chandeliers, and red marble escalator make it look like the foyer of a grand opera house.

The best place to see examples of all the 19th-century urban railways in Britain is the London Transport Museum, in Covent Garden. Equally impressive is the National Tramways Museum in Crich, Derbyshire, which commemorates the horse-drawn and electric trams of the late 19th and early 20th centuries.

OVERGROUND RAILWAYS

The success of the New York subway led to the dismantling of the elevated railways in Manhattan during the 1930s and 1940s. While overground systems have fewer problems with ventilation and offer more sightseeing opportunities, the streets below them become dark and noisy.

Chicago, unlike Manhattan, decided to keep some overhead railways, notably the Loop in the center of the city, which is supplied by trains arriving from all the Chicago suburbs. It's always a pleasure to watch the intricate interaction of the distinctive silver trains on the Loop, coordinated to ensure the safe crossing of trains just ahead.

The rapid transit system, or H-Bahn, in Wuppertal, Germany, featured a different spin on the overground railway. The essential problem was the same—how to move large numbers of people quickly and efficiently in a place where streets were crowded and property was expensive. Wuppertal's solution was to build a line following the course of the Wupper River. A long series of steel A-frames, with their legs embedded on the banks of the river, hold up a track parallel to the surface of the river. But the trains themselves, rather than sitting on the wheels, hang underneath them, below the track. First opened in stages between 1901 and 1903, after Kaiser Wilhelm II had enjoyed a ride, the line runs for 8 miles and has now operated effectively for more than a century.

AESTHETICS

Some subway systems tried hard from the outset to be beautiful: Moscow, above all, but also the Paris Metro, with its lovely art nouveau stations, and Sweden's Stockholm system, with its T-Centralen station, which has a cheering design of blue leaves on a white background, and the Kungsträdgården station, which features multicolored murals, mosaics, old pillars, chimneys, and fireplaces.

KUNGSTRÄDGÅRDEN STATION

The most impressive new Tube station in London is probably Westminster, a steel and concrete cavern that looks like a science fiction movie set. The most impressive in New York is the Oculus, designed by the Spanish architect Santiago Calatrava and built as part of the renewal of the area around Ground Zero. Half of it is below ground. The interior is an exhilarating space in white concrete and glass, and the central open atrium is surrounded by shops, galleries, balconies, and train stations at each end.

The world's great cities today could not function without their railways, above and below ground. They are so familiar by now that it's easy to miss their significance. Next time you're riding an underground train or street railway, spare a thought for the people who planned and built it and think about how difficult your journey would be if it wasn't there.

READING

Grant, H. Roger. *Electric Interurbans and the American People*. Bloomington: Indiana University Press, 2016.

Morris, John E. *Subway: The Curiosities, Secrets, and Unofficial History of the New York City Transit System*. New York: Black Dog & Leventhal, 2020.

Wolmar, Christian. *The Subterranean Railway: How the London Underground Was Built and How It Changed the City Forever*. London: Atlantic Books, 2021.

12

Great Railway Stations of the World

The first generation of railway engineers and architects had to create a range of unprecedented structures. Among the most challenging were stations. Builders realized early on that stations should be both functional and attractive. In this lecture, you'll visit some of the world's most impressive railway stations. Nearly all the greatest stations were built between 1840 and 1930, a period of rapid change in architectural fashions and one in which a wide range of new materials became available, allowing for experimentation in design.

EARLY BRITISH STATIONS

The grandest buildings in London in 1830 were either churches, fortresses, or palaces, such as St. Paul's Cathedral, the Tower of London, and Buckingham Palace. These structures were the available models of what a big building should look like. Train stations, like forts, had to be functional above all, but they could also be distinguished.

London was already an old city. Only by demolishing large sections of it could railways come into the city center. Vested interests were strong enough to prevent that from happening, so London never developed one central station. Instead, more than 10 terminal stations were built in areas that were then London's inner suburbs.

A new building material, mass-produced plate glass, arrived just in time. London's Great Exhibition of 1851 was housed in a revolutionary building, the Crystal Palace, designed by Joseph Paxton using iron frames and plate glass. It could enclose and illuminate a large space at relatively low cost and low weight. Iron frames and plate glass were ideal for railway station roofs, too.

Two of the most coveted locations were taken by Charing Cross and Cannon Street stations in the 1860s. They served commuters coming from south of the Thames River but were built on the north bank of the river, making them more convenient to the city's business district. Trains to and from Charing Cross offer grand views of the Thames in both directions.

The most impressive of all was St. Pancras, whose single massive arched roof was designed by William Barlow, the Midland Railway's chief engineer. Built in the mid-1860s and renovated in the early 21st century, St. Pancras is now the starting point for Eurostar trains that whisk passengers to Brussels and Paris through the Channel Tunnel.

Builders of the great terminal stations also set up grand hotels for the convenience of passengers. Again, St. Pancras outshone its rivals, building not just a memorable hotel but one of the most spectacular buildings in Britain. George Gilbert Scott designed it in neo-Gothic style and built it in

polychromatic brick. The interior features numerous arches, highly decorated ceilings and meeting rooms, and a beautiful central staircase. Even the curving corridors are inventive, graceful, and elaborately decorated.

Among mainline stations in Britain, Edinburgh Waverley is probably the best of the lot. The station sits in a valley between the old medieval city to its south and the 18th-century New Town to its north. Before 1800, this valley was a swampy, garbage-filled lake that contributed much to the city's unhealthy atmosphere and low life expectancy. The arrival of the railway worked wonders for Edinburgh because its engineers drained the swamp. Impressive buildings rise on both sides of the line, making arrival at Edinburgh one of the high points of train travel in Britain.

King's Cross station opened in 1852 and was renovated in 2012. Express trains, such as the *Flying Scotsman*, depart from here on high-speed runs to Edinburgh, and children gather to see Platform 9¾, where Harry Potter set out for Scotland on the *Hogwarts Express*.

EARLY AMERICAN STATIONS

New York City's Grand Central Station, one of America's most admired terminals, was completed in 1913. Its tracks run underground, and the main concourse is separated from the platforms. Its breathtaking interior features elegant, curved staircases at each end that lead up to street level. A four-faced golden clock stands over the information kiosk, intricate ironwork decorates the ticket office windows, and superb chandeliers illuminate the corridors and the great open spaces.

Union Station, located on Capitol Hill in Washington DC, marks the southern end of the Northeast Corridor, which links Washington, Baltimore, Philadelphia, Newark, New York, New Haven, Providence, and Boston. Authorized by Congress in legislation signed by Theodore Roosevelt, it was completed in 1907 to a design by William Pierce Anderson, who worked at the prestigious Daniel Burnham company in Chicago.

The splendid central hall is based on the Baths of Diocletian in Rome and features 36 life-sized statues of Roman legionnaires around its perimeter. Above the grand entrance, itself based on the Arch of Constantine in Rome, stand six statues of classical figures that represent the progress of railroading: fire, electricity, justice, imagination, agriculture, and mechanics.

Chicago's Union Station, opened in 1925, is comparable to Grand Central Station in New York. The main hall has survived, beautifully restored to its original splendor, showcasing two statues: the goddesses of night holding an owl and the goddess of day holding a rooster. Immense marble columns dwarf the waiting passengers, and upward-facing brass lanterns add to the dramatic effect.

Small-town railroad stations, or depots, often became the focal point of town life. Citizens congregated at their local stations to watch the arrival and departure of the daily trains, set their watches by the station clock, and learn news of the outside world from the station telegrapher.

EARLY EUROPEAN STATIONS

Among Europe's many superb railway stations, king of them all is the Milan Central station in Italy. It was begun in 1912 but completed only in 1931, when Mussolini was the dictator. Its original architect was inspired by Union Station in Washington DC. Three massive square arches mark the entrance. Inside is a series of cavernous halls, soaring upward and heavily decorated with friezes of ancient warfare, bundles of fasces (the fascist symbol), mosaics, and illustrations of Italy's cities on tile. Milan is the great commercial hub of northern Italy. Today, a constant stream of high-speed trains travel to and from cities in France, Germany, and Austria, through the great tunnels that pierce the Swiss Alps.

In Spain, Madrid's main station, Atocha, offers visitors a surprise. Expecting to find trains behind the late-19th-century facade, they encounter a great tropical garden, hot and humid, under the great iron arches. The garden is flanked by offices, shops, and restaurants. After walking another hundred yards, travelers come to the trains, which begin and end their journeys under a great canopy of steel and concrete attached to the older building. This change was made in 1992 to cope with increasing traffic.

In Barcelona, the Estació de França is a marvel, even though it carries only local and regional services. Built in 1929 for an international exposition, the station projects an air of faded glory, but what makes it so memorable is the dramatic effect created by the vast curve on which it's built. The head building features heavy stonework and massive wrought iron gates as well as a mosaic floor and shallow domes overhead.

Another European favorite is Helsinki Central Station, built in the second decade of the 20th century when Finnish nationalists were struggling for independence from the Russian empire. Its entrance is flanked by four stone giants that bring to mind the grim gods of Nordic folklore. Equally impressive are the great arched window and the clock tower that loom behind these giants. The designer was Eliel Saarinen, father of the architect Eero Saarinen, who would later build the distinctive swoop-shaped roof of Dulles International Airport outside Washington DC and the great arch in St. Louis, Missouri.

The Gare du Nord, or North Station, in Paris, receives passengers from London on the high-speed *Eurostar* train. It's also the busiest railway station in Europe, coping with tens of thousands of daily commuters as well as long-distance travelers. Built in the 1860s to replace a smaller station, its architect had to rely on great iron beams and columns imported from Glasgow in Scotland to hold up the interior roof because the French iron industry was not yet capable of anything on such a scale.

Equally attractive is the Gare de l'Est, or East Station. It was the principal station for French soldiers heading to the front lines in World War I. A painting of departing soldiers by an American artist named Albert Herter, whose own son Everit died in the last year of the war, hangs in the station. Close by are memorials to railway workers who died in both world wars and to the approximately 70,000 French Jews who were deported to the death camps in World War II, of whom only 2,500 returned.

In Germany, Cologne Central Station sits adjacent to the medieval Catholic cathedral and the magnificent Hohenzollern Bridge. This steel bridge, named for the Prussian royal family, was finished immediately before World War I and includes equestrian statues of several famous kings. It is the busiest railway bridge in Germany, carrying about 1,200 trains every day into the station that lies just beyond. Its three great spans cross the Rhine River, itself one of Europe's busiest commercial arteries.

Beyond Europe, of course, many more extraordinary railway stations exist. This lecture closes by paying tribute to one of them: Chhatrapati Shivaji Terminus in Mumbai. Designed by Frederick William Stevens, it was originally named Victoria Terminus when Mumbai was still called Bombay and was a vital part of the British Empire. It was begun in 1877 and completed 10 years later, on the 50th anniversary of Queen Victoria's accession. Built in a brilliantly eccentric combination of styles, the station features a high central dome that is topped with a statue representing progress, and it bristles with turrets, towers, arches, statues, and gratuitous decorations, including a statue of a lion to represent Britain and one of a tiger to represent India.

When the British left India, the statues of British dignitaries were removed one by one. No one knows what happened to the statue of Queen Victoria, which once enjoyed pride of place on the central façade just beneath the clock. That niche now stands empty.

During World War II, most of Cologne was reduced to rubble. The Hohenzollern Bridge fell into the river, and both the station and the nearby Cologne Cathedral were heavily damaged. All were rebuilt in the 1950s and 1960s, during Germany's "economic miracle."

READING

Jenkins, Simon. *Britain's One Hundred Best Railway Stations*. London: Viking, 2018.

Potter, Janet Greenstein. *Great American Railroad Stations*. New York: Wiley, 1996.

Wolmar, Christian. *Cathedrals of Steam: How London's Great Stations Were Built and How They Transformed the City*. New York: Atlantic Books, 2022.

13

The Challenge of Cars, Trucks, and Planes

In the early decades of the 20th century, railways struggled against a pair of talented new rivals: motor vehicles and aircraft. But those challenges weren't the only ones the rail industry faced. This lecture looks at how government regulation, World War I, and the crippling effects of the Great Depression all tested the resilience of railroads on both sides of the Atlantic.

EMERGING COMPETITORS

The first motor vehicles were built in the 1880s and 1890s, decades when the railways were achieving maturity. At first, cars seemed to present little threat to railways because there were few good roads, especially between cities. Early American carmakers were keenly aware of the problem, and some of them began building paved highways. From the 1920s onward, local, state, and federal governments became road builders on a large scale.

Another competitor, aviation, made great strides in the decades after the Wright brothers' first flight of 1903. The outbreak of World War I in 1914 gave a massive stimulus to research and development in aviation, and by the war's end, in 1918, aircraft were reliable, fast, and capable of steadily greater distances. During the interwar years, aircraft grew not only safer but also bigger, raising the possibility that they would eventually become the logical first choice for long-distance intercity travel.

At first, the railways had many advantages over these new competitors. They had a large head start and had invested heavily in improving the comfort and safety of their trains as well as the quality of their lines. Among these improvements were steel rails, steel carriages, air brakes, sleeper cars, and restaurant cars.

REGULATING RAILWAYS

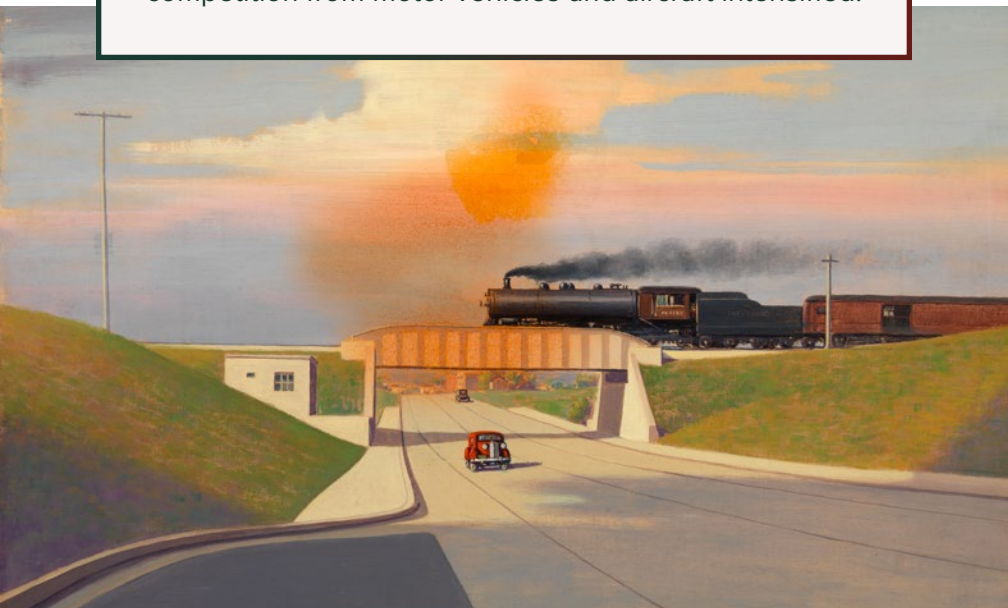
Despite their many advantages, American railroads also faced serious challenges in the early 20th century. One was a public relations problem, which had grown out of their misconduct in the post–Civil War era. The muckraking press denounced railroad moguls such as Jay Gould, Cornelius Vanderbilt, and Leland Stanford as robber barons who mistreated their workers, bullied small businesses, and made sweetheart deals with favored corporations.

The Granger movement of the 1870s was a farmers' movement protesting against railroads for charging them high shipping rates. State governments in Illinois, Iowa, Minnesota, and Wisconsin passed Granger laws that forbade

discriminatory shipping rates. When the Supreme Court overturned one of the laws in 1886, Congress responded to public anger by passing the Interstate Commerce Act of 1887. It banned discriminatory shipping rates and created the Interstate Commerce Commission (ICC), the first federal regulatory agency. In the ensuing decades, the ICC developed an elaborate set of rules governing what services the railroads must provide and the amounts they could charge to passengers and shippers.

The ICC's powers were strengthened by acts of Congress in 1903, 1906, and 1910, empowering it to investigate accidents, mandate improvements, inspect track quality, and regulate speeds. The Hepburn Act of 1906 specified the maximum rates railroads could charge for shipping many goods. The act also enforced a standardized system of accounting and gave the ICC the right to inspect these accounts.

The cumulative effect of railway regulation in the early 20th century was to reduce railroads' flexibility of action, something they were going to need as the competition from motor vehicles and aircraft intensified.



Another way in which government intruded on railway operations was the Southern states' segregation laws. One by one, the former Confederate states passed laws mandating the separation of the races in public places, including railroads. Many of the railroads opposed these laws, not because they were enlightened on racial matters but because it obliged them to attach more carriages to trains and thus drove up their fuel costs. In 1892, Homer Plessy, a light-skinned man who was legally Black according to Louisiana law, sat in a first-class Whites-only carriage on the East Louisiana Railroad to test the constitutionality of the Louisiana Separate Car Act of 1890. Plessy was arrested and convicted of violating the law, and the US Supreme Court, in a 7–1 decision, upheld the verdict, asserting that segregation was not unconstitutional. "Separate but equal" remained the law until the *Brown v. Board of Education* case of 1954.

PREVENTING MONOPOLIES

The Sherman Antitrust Act of 1890, designed to prevent the creation of monopolies, was another challenge facing the railroads. American economic orthodoxy at the time feared monopoly because it would end the benefits that come to consumers from having producers compete with one another to improve quality and reduce prices. Railroads, by contrast, feared competition, especially on major routes, and wanted to create cartels—pricing agreements among all the competitors to ensure that all could stay in business and prosper. Meanwhile, they would charge higher prices in places where they were the only option and, in effect, already held a monopoly.

James J. Hill, a Minnesota entrepreneur, built the Great Northern Railroad from Minneapolis to Seattle and then took over its rival, the Northern Pacific. He then tried to buy up the Chicago, Burlington, and Quincy Railroad, giving him a link to Chicago. James and his financial partners incorporated the Northern Securities Holding Company in New Jersey to control all three. But in 1902, President Theodore Roosevelt invoked the Sherman Act and ordered the Justice Department to prosecute the securities company as a monopoly. The Supreme Court agreed and, by its 1904 verdict, compelled the company to break up so that competition could be restored.

From 1906 onward, the railroad companies claimed that they were being denied the right to charge their shippers high enough prices and, therefore, could not keep up with maintenance and replacement of equipment. Even so, these were prosperous years, and they marked the era when America reached its greatest mileage of railroads. In 1916, the US had almost 250,000 miles of track—compared with roughly 140,000 miles today.

NATIONALIZING AND CONSOLIDATING RAILWAYS

American entry into World War I in 1917 brought many problems to a head. Sending war goods to Britain and France had stimulated an economic boom, but now that America was directly involved, increased demands stressed railroads to the breaking point. Tens of thousands of freight cars jammed up East Coast ports because they could not be unloaded quickly enough.

As a result, President Woodrow Wilson nationalized the entire railway system and created a centralized United States Railroad Administration. This temporary arrangement ended in 1920, when the railroads were returned to private ownership. The ICC, however, retained a high level of supervision.

World War I and the rise of motor vehicles created a crisis for the railways of Britain, too. Its government also took over the entire system for the duration of the war, emphasizing the need for efficiency and standardization. When the war was over, Parliament passed the Railways Act of 1921, consolidating 120 railway companies into just four big ones: the London, Midland, and Scottish Railway(LMS); the London and North Eastern Railway (LNER); the SouthernRailway; and the Great Western Railway. As in America, a high degree of regulatory oversight remained, but the principle of private ownership was respected.

This grouping process went into effect on January 1, 1923. The results were disappointing from an economic point of view, as competition with trucking companies increased and the railway's flexibility decreased. Worse, the Big Four, as they were called, had been operating for only 6 years when the Great Depression began.

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STREAMLINING LOCOMOTIVES

By the 1920s, cars and aircraft were maturing and offering more competition to the railways every year. Interwar railway companies sought to hold their own by increasing speed and improving service. They experimented with streamlining, creating sleek designs that reduced wind resistance, used less fuel, and made a stylish presentation.

The most successful streamlined locomotives in Britain were the A4 class, designed by Nigel Gresley. The A4s pulled express trains on the British east coast main line between London and Edinburgh from the 1930s until the early 1960s. William Stanier, chief engineer of the LMS, designed the Coronation-class locomotives, some of which were also streamlined, to compete with the A4s for fastest times from London to Scotland.

While the LNER and the LMS concentrated on speed and luxury in the interwar years, the Southern Railway aimed for a different kind of modern appeal by electrifying all the suburban commuter lines that came from south of the river Thames into London. Speed and frequency of service on the Southern Railway also meant that towns throughout the South of England could become commuter dormitories.

American railroads also experimented with adding streamlining to steam locomotives for their prestige expresses, such as New York Central's *20th Century Limited* from New York to Chicago and Pennsylvania Railroad's *Royal Blue* service from New York to Washington DC.

SHIFTING FROM STEAM TO DIESEL POWER

German inventor and engineer Rudolf Diesel built his first engines in the 1890s, and the technology improved steadily after that. By 1933, a light two-car diesel-powered train in Germany named the *Flying Hamburger* was making scheduled runs between Berlin and Hamburg at speeds above 70

mph. The following year, the Union Pacific Railroad introduced its first streamlined diesel-powered train, the City of Salina, which ran a clean, high-speed service between Kansas City and Salina, Kansas.

Diesels had many advantages over steam-powered trains. They needed less maintenance, used less fuel, and created less pollution. They also reached their cruising speed more quickly than steam engines and put less stress on the rails as they accelerated.

Diesels' disadvantages in the early 1930s were that they could not yet match the raw power of the big steam locomotives and were very expensive. Further research and development overcame the power problem. In the mid-1940s, the railroads, flush with money from boom conditions during World War II, rapidly shifted from steam to diesel power, phasing out steam locomotives almost completely by the mid-1950s.

Union Pacific's *M-10001* broke the record for the fastest cross-country rail journey in October 1934, traveling from Los Angeles to New York City in 57 hours, a record that stands to this day.

READING

Bonavia, Michael. *The Four Great Railways*. London: David and Charles, 1980.

Gallamore, Robert, and John R. Meyer. *American Railroads: Decline and Renaissance in the Twentieth Century*. Cambridge, MA: Harvard University Press, 2016.

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Railways in the Two World Wars

In the early years of the 20th century, the great powers of Europe intensified an already dangerous arms race to protect themselves from a surprise attack. Conventional wisdom among British, French, and German war planners was that if a war broke out, it would be won almost at once by whichever side mobilized most quickly. World War I broke out in 1914 amid this state of tension. But, as you'll see in this lecture, the bloody 4 years that followed revealed the deep flaws of conventional wisdom. And though military planners learned some important lessons from World War I, World War II brought a new set of challenges.

RAILWAYS DURING WORLD WAR I

Germany's Schlieffen Plan was a detailed blueprint for the rapid invasion of Belgium and France and the encirclement of Paris. The plan entailed seizing control of Belgian and French railways and then coordinating them closely with the German network. The Germans built huge stations in towns close to the French and Belgian frontiers, which tipped off those governments that the stations were designated jumping-off points for an invasion. The French made comparable plans on their side, albeit with a more defensive intention. Both armies knew that highly coordinated rail systems were essential for taking their soldiers to the front and keeping them supplied.

When the war began, the Schlieffen Plan went into action—only to run into an immediate surprise. The Germans had not considered the possibility that the Belgians would deliberately sabotage their own railways rather than let them fall into German hands. But the Belgians did exactly that, slowing the German advance. Blowing up tunnels was a particularly effective step since repairing them would take months. The situation was made worse by the fact that the British army had arrived—having also implemented a meticulous railway plan—and was launching counterattacks against the Germans. Britain had learned how to execute a military mobilization by rail during the Boer War at the turn of the century.

Railways turned out to be much better as a defensive weapon than an offensive one. The same was true of artillery, barbed wire, trenches, and machine guns, all of which gave the advantage to defenders over attackers between 1914 and 1918. The defense advantage ought to have been obvious to the war planners, but their preoccupation with the initial attack and their certainty that an industrialized war was going to be won and lost quickly had prevented them from thinking through what might happen if the initial attack failed.

Once the armies dug into trench lines, railways could supply them from the rear, bringing up supplies to the nearest station, which, for safety reasons, had to be between 5 and 7 miles behind the front lines. From there, supplies were brought closer to the trenches on temporary narrow-gauge railways, with which all the armies experimented.

Once an army attacked and advanced, however, it left its rail services behind. Time after time, advances succeeded at first but then sputtered out because the advancing soldiers, on foot, lacked adequate resupply and communications, whereas the retreating defenders converged on their own supply depots. Not until the Allies deployed tanks in large numbers, in the last year of the war, did a mechanized offensive weapon begin to redress the imbalance between attack and defense, and by then the German economy itself was breaking down.

When the Germans agreed to an armistice in 1918, they signed the cease-fire in a railway carriage at Compiègne. In 1940, Adolf Hitler forced the French to surrender in the same railroad car, which was destroyed during the war. An exact replica stands there today, an apt symbol of railroads' importance in the two world wars.

"KEEP 'EM ROLLING"

THE RAILROADS ARE THE FIRST LINE OF DEFENSE

Only on the Eastern Front of World War I was Germany victorious, and one railway train played a key rolein this victory. Russian military failures led to the outbreak of revolution in 1917 and the overthrow of the tsar. The Germans were annoyed to discover that Russia's new provisional government under Aleksandr Kerensky pledged to Britain and France that it would maintain the war effort. Only one group among the many Russian political factions was determined to end the fighting: the Bolsheviks. This determination made them temporarily popular. Their leader, Vladimir Lenin, had been living in exile in Zürich, Switzerland. Germany offered Lenin and several other Bolshevik exiles a train to carry them across Germany to the Baltic Sea, where they traveled by ferry to Sweden. From there, they traveled through Finland to St. Petersburg in Russia. As soon as Lenin arrived, he organized the Bolsheviks to overthrow the Provisional Government, depose Kerensky, and declare the dictatorship of the proletariat. Then he sent a delegation to open peace negotiations at Brest-Litovsk to end the war, even though it meant Russia would give up many of its Eastern European possessions.

RAILWAYS DURING THE INTERWAR YEARS

In the Russian Civil War that followed the 1917 revolution, the Communist army commander, Leon Trotsky, became famous for his travels in an armored train named the *Predrevoyensoviet*. The train was an effective weapon in the era before air power rendered armored trains vulnerable. It was well stocked with first-rate soldiers, including a company of infantry and a squad of cavalry who could range out from the train at critical locations.

Lenin, Trotsky, and their successor, Stalin, understood the importance of railways in rescuing Russia from economic backwardness. Trains were prominent on the Soviet posters of the 1920s and 1930s, along with tractors, dams, aircraft, and power stations—the icons of industrialization. The reality rarely lived up to the ideal. John Scott, an American communist who volunteered to work at Magnitogorsk, a new steel-factory town in the Urals, described the rickety condition of Soviet trains in the 1930s, their constant tendency to break down or derail, and the sheer discomfort of Soviet train travel.

Other autocrats of the interwar period were similarly devoted to rail travel. The Italian dictator Benito Mussolini's declaration that he could "make the trains run on time" was essentially a metaphor for effective government and efficiency in a country plagued with slovenly habits and a preindustrial approach to timekeeping. But the Italian railway network was in catastrophic disarray by the end of World War I due to overuse and inadequate maintenance. Mussolini's predecessors between 1918 and 1922 began a system of repairs and improvement, for which he then took credit, but Italy's trains were not reliable or punctual in the 1920s and 1930s.

RAILWAYS DURING WORLD WAR II

Adolf Hitler, the German dictator who came to power in 1933, astonished the world in 1940 by conquering France in 6 weeks. His swift conquest of Poland, Denmark, Norway, Belgium, the Netherlands, and France enabled him, for a time, to neglect the centrality of railways to military logistics. But reality caught up with him when he launched Operation Barbarossa, the invasion of Russia, in June 1941. Too few railways, along with awful roads, forced him back into using horses and even handcarts for much of his army's supply. In addition, Russia's railways were built to a different gauge than Germany's, so every railway had to be painstakingly modified or cargos had to be offloaded from one train and reloaded onto another before they could proceed.

Russian railways were also frail, and the heavy German locomotives moving over them began to damage the rails. Then the notorious Russian winter set in, with temperatures so low that German locomotives, never built for such conditions, ceased functioning altogether. The Eastern Front became a logistical nightmare. German soldiers lacked basic items such as coats to protect them against the cold, and thousands froze to death in thin summer uniforms.

Russia was able to recover from its initial shock of Germany's invasion. It fortified the key cities of Moscow, Leningrad, and later Stalingrad and then began its long and brutal counteroffensive, which culminated in the conquest of Eastern Europe and Germany. Although the Russians lost far more men than any other nation in World War II, they also played the lion's share in destroying Hitler's Wehrmacht on the ground.

Railways took on sinister associations in World War II because of the way they were employed in the Holocaust. The Nazis established camps in remote areas of eastern Germany and Poland, of which the most notorious was Auschwitz. Trains from all the nations Hitler had conquered steamed into Auschwitz with wagons crowded with Jewish people, nearly all of whom were destined to die in the camps.

In the United States, the railroad companies entered World War II with embarrassed memories of what had happened during their brief participation in World War I. Dozens of private companies had failed to cooperate effectively, leading to severe delays and bottlenecks—which in turn had prompted the federal government to seize control of the nation's railways.

When America again went to war, after Pearl Harbor, President Franklin Roosevelt asked for voluntary cooperation from the private companies that owned all the major railroads, and he got it. Domestically, more than 90% of war-related transport went by rail, including virtually all the men who were called into service. Ports on the East and West Coasts were involved as shipping centers, management was more sophisticated, and the bottlenecks of World War I were avoided.

The busiest year in the history of American passenger railroading was 1944.

In the lead-up to the D-Day invasion of Normandy, hundreds of thousands of British, American, and Canadian soldiers concentrated in and around the south coast of England, preparing to board the armada that would carry them across the English Channel. Supplying them with equipment, clothing, and food stretched the British railways to their limits.

D-Day, June 6, 1944, was a success, as was the follow-up landing of masses of Allied equipment and reinforcements. Photographs of the D-Day beaches a few days after the first landings show makeshift railways coming right down to the waterline to facilitate rapid movement of heavy goods inland. By the time the fighting came to an end 11 months later, in May 1945, large areas of Europe lay devastated, especially Germany, whose industrial infrastructure had been pulverized.

The victorious Allies now had to decide whether the shattered railways and the industrial heart of Germany should be rebuilt. The rising tensions of the Cold War led to rapid industrial recovery, the Marshall Plan, and the restoration of West German economic power, with railways front and center. Trains had played a crucial role in two global conflagrations. Now, in the wake of the second, it was clear they had a part to play in putting Europe back together.

READING

Foley, Michael. *Britain's Railways in the First World War*. Yorkshire: Pen & Sword Transport, 2021.

Mierzejewski, Alfred. *The Most Valuable Asset of the Reich: A History of the German National Railway, Volume 2, 1935–1945*. Chapel Hill: University of North Carolina Press, 2014.

Williams, Michael. *Steaming to Victory: How Britain's Railways Won the War*. London: Random House, 2013.

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Railways in Literature

Nineteenth-century novelists described a rapidly changing world, as new technologies, ideas, and social classes rose to prominence. The railroads were a vital part of these changes. This lecture looks at how railways became a central element of European and American literature after about 1840, carrying the characters from place to place, bringing members of different social classes together, symbolizing the new industrial world, and sometimes endangering people who were unaccustomed to their speed.

RAILWAYS IN BRITISH NOVELS

Charles Dickens, the popular genius of early Victorian fiction, was among the first authors to incorporate railways into fiction. *Dombey and Son*, serialized in the late 1840s and published as a book in 1848, depicts the scene in Camden Town, part of north London, as old slum districts are cleared away to make room for the new railway. Later, one of the book's nastier characters, James Carker, watches trains go by and thinks of them as fiery devils with a great power for evil or as giants with dull red eyes. The next day, distracted, Carker accidentally steps off the station platform and is killed by a speeding train. He thus became one of the first of many fictional characters to die in this way, sometimes by accident, sometimes as suicides.

In 1865, Charles Dickens was traveling on a train that derailed. Despite his carriage hanging off a bridge, he was unhurt and able to climb out and help many of the victims, some of whom died. His children recalled that after the accident, he was never in good health and train travel made him sweat with anxiety.

George Eliot's *Middlemarch,* published in eight parts between 1871 and 1872 but set 40 years earlier, shows rural people suspicious of railways, which were a strange novelty at that time. Recreating in fiction a scene that had often been played out in reality during the 1830s, Eliot shows a group of farm laborers threatening the railway surveyors who have come to chart the course of a new line. The farm workers brandish pitchforks and drive the surveyors away. Caleb Garth, one of the book's most sympathetic figures, tries to calm them. They eventually disperse but wander away muttering that the only people who will benefit from railways are the rich, leaving poor men like themselves further behind than ever.

By the time *Middlemarch* appeared, railways had been thoroughly integrated into English life. Anthony Trollope, the prolific mid-Victorian novelist, constantly moved his characters from place to place by train without even remarking on the railway as a novelty.

Trollope used the American railroad scandals of the 1870s as a plot device in *The Way We Live Now*. It was serialized just as the details of the Crédit Mobilier Scandal were becoming public. In the novel, Hamilton Fisker is an American railroad promoter, seeking capital in Britain and promising huge profits. Unscrupulous businessmen in London, especially Mr. Melmotte, are quick to join in, whipping up a railway fever to attract big investors. Fisker's and Melmotte's insider dealings will make them a fortune as long as they sell at the right moment, even if no railway actually gets built. Other characters are depicted as naïve for not grasping their scheme.

RAILWAYS IN RUSSIAN AND FRENCH NOVELS

In Leo Tolstoy's 1878 masterpiece, *Anna Karenina*, the comfortable train traveling between St. Petersburg and Moscow represents the privileged life of the upper classes. In one scene, Anna is snug inside her first-class sleeping compartment, reading an English novel, while a blizzard rages outside her window. She sees a train worker pass by completely coated in frost down one side of his body. She steps down at a provincial station to get a breath of fresh air despite the intense cold. There, she bumps into Vronsky, the man who will soon become her lover. This scene is emblematic of the book itself, which describes her decision to leave the comfortable interior of the Russian elite for an illicit love affair with Vronsky, exposing her to the icy contempt of society.

For many authors, railways were useful as metaphors, as instruments for moving the characters, and as symbols of a changing world.

VRONSKY ENCOUNTERS ANNA AT THE STATION.

Tolstoy disliked railways as an exotic imported luxury for the privileged few, and so does his alter ego in the book, Konstantine Levin, who writes a critical account of them in his own book about modern Russia. Important scenes at the beginning and end of *Anna Karenina* also show that railways, whatever their benefits, can be deadly. Anna comes to Moscow at the beginning of the novel on a train that runs over a man, killing him and mangling his body. At its end, when all her hopes have been destroyed and her lover has deserted her, Anna is again at a railway station. "And all at once she thought of the man crushed by the train the day she had first met Vronsky, and she knew what she had to do." She ends her own life by deliberately throwing herself under a train.

Émile Zola, the great French novelist of the late 19th century, studied the way of life of the men who worked on the railways. Details of their work, their routines, and the timetables by which they lived are central to his 1890 novel, *La Bête humaine*. The main character is a proud train driver, Jacques Lantier, who drives the Paris–Le Havre express twice each week.

One bravura passage shows Jacques and his fireman Pecqueux struggling to get the express to Paris in a driving snowstorm, straining every muscle, braving the intense cold, digging out the locomotive when it stalls in snowdrifts, soothing the anxieties of querulous passengers, and finally limping, exhausted, to their destination. Their locomotive, La Lison, is a character in its own right, a friend to both of them for its good running habits, economy, and reliability. When La Lison is destroyed in a terrible crash, Zola describes the mutilation of many passengers in detail but intensifies his language as he describes the locomotive's "death," so that the reader feels more pain at its destruction than for any of the human victims.

RAILWAYS IN AMERICAN NOVELS

The American novelist Frank Norris described the railway with a metaphor of an octopus whose tentacles grasp everything and destroy everyone who gets in its way. Norris was disgusted by the political and financial power of the Southern Pacific Railroad in California, which gouged wheat farmers by charging them excessive shipping rates and by forcing up the price of lands

originally granted to them by the government. He learned of the Mussel Slough Tragedy in California, an 1880 incident in which these tensions had come to a head, leading a group of farmers to fight a lethal gun battle against agents of the Southern Pacific. As Norris transfigures the incident in his 1901 novel, *The Octopus*, the farmers are productive businessmen, transforming the land from sterility to abundance, whereas the railroad is a parasite whose only motive is to squeeze as much profit as it can from the hardworking men whose livelihood depends on it.

At the end of *The Octopus*, however, Norris makes a sharp distinction between the evil the railway companies had done, especially to the farmers, and the ultimate good that would flow from the existence of both the farms and the railroad. The wheat that the farmers had grown was now on its way to alleviate a famine in India, and its existence was an unquestionable good.

Many other American novelists of the early 20th century depicted railways simply as a central element of the nation's life. Sinclair Lewis, the first American to win a Nobel Prize for Literature, used the railway as a practical device to move his characters from place to place, especially from the country to the city and back.

In Theodore Dreiser's 1900 novel, *Sister Carrie*, a train going from the countryside to a city starts the action. The protagonist, Caroline Meeber, is eager to leave her dull rural Wisconsin home to seek her fortune in Chicago. On the train she meets a traveling salesman, whose ostentatious dress and concern for her welfare attract her favorable notice. He is to be her seducer, leading her into a life of sexual dependency on rich but unscrupulous men. Using a well-worn tradition—that the countryside is the home of virtue and the city is the home of vice—Dreiser sends Carrie by train onto the downward path.

A large subgenre of American literature was the railroad story, which thrived between about 1880 and World War II. Its characters were the men who worked on the railways; their work often involved building and repairing them, driving the trains, sending Morse code messages, running the divisions, handling freight, or manning the depots. Frank Spearman was a prolific contributor to this genre, which he often blended with the familiar western themes of cowboys, Indians, and outlaws.

NOVELS SET ON THE ORIENT EXPRESS

Two English novels from the 1930s are set on the *Orient Express*, one of the great European luxury trains of the era. The first is Graham Greene's *Orient Express*, also known by its original title, *Stamboul Train*. The story follows an odd assortment of people with different backgrounds and professions who come together solely because they all need to move east through Europe on the same day.

Greene imagines how the movement of the train through successive countries during an era of political instability will provoke moments of crisis and alliances of convenience among them. Without the train itself, none of the meetings or incidents would have taken place. It's a shrewd commentary on Greene's era, on social class and prejudice, and on human vulnerability.

Agatha Christie's *Murder on the Orient Express* is better known by now. In some ways, it does the exact opposite of Greene's *Orient Express.* His theme was the coming together of a group of people by chance, whereas her theme is the coming together of a group of people seemingly by chance but actually by design. At first, the passengers seem to have nothing in common, but the last-minute addition to the passenger list of detective Hercule Poirot changes everything. First, a passenger on board is killed, and then the train gets stuck in mountain snow, which gives Poirot the time to solve the case. Assuming at first that it must have been one of the passengers who committed the murder, he eventually realizes that it was all of them and that they had used the randomness of any train's collection of passengers to disguise their deed. Here, too, as with Graham Greene, the train has made possible a sequence of events that could not otherwise have taken place.

READING

Norris, Frank. *The Octopus*. 1901. New York: Penguin Classics, 1994.

Spearman, Frank. *Whispering Smith.* 1906. Akron, OH: Summit Classic Collector Editions, 2013.

Zola, Émile. *The Beast Within*. 1890. New York: Penguin Classics, 2008.

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Railways in Art and Photography

Photographs, drawings, and paintings provide a rich visual record of railway history right from the beginning. Photography, like steam railways, began in the 1820s and 1830s. This lecture explores how artists have depicted trains over the last 200 years not just as a means of transportation but also as symbols of power, movement, modernity, conquest, and elegy. As you'll see, some artists were drawn to the trains themselves, while others found inspiration in the stations, passengers, and landscapes.

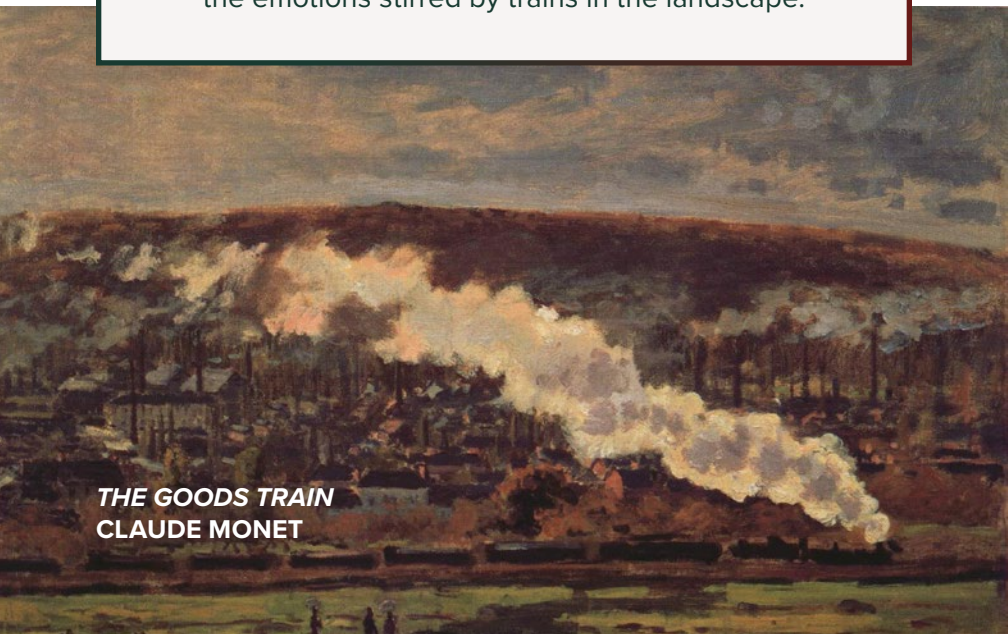
19TH-CENTURY RAILWAY PAINTINGS

Joseph Turner was one of the great painters of 19th-century England. In 1844, he completed *Rain, Steam, and Speed—The Great Western Railway*, the earliest attempt by a major artist to incorporate trains and railway architecture into a landscape. With a technique that foreshadows the impressionists, Turner uses smudges of color to give the feeling of a storm, through which a train steams over a river bridge. The painting creates a vivid sense of striving against difficult conditions, with the glow of a half-veiled sun echoing the glow of the locomotive. In the background are an old stone bridge and a little boat, perhaps representing the stability of the old world, which is now being replaced by something mobile, fast, and new.

RAIN, STEAM, AND SPEED—THE GREAT WESTERN RAILWAY
JOSEPH TURNER

The impressionist painter Claude Monet also saw artistic opportunities in railways. His 1872 painting *The Goods Train* is not dominated by the train itself but by the smoke that it generates. Against a subdued brown and gray background, it makes a bright white diagonal tinged with pink, lilac, and yellow. Later in the 1870s, he painted a twilight scene called *The Train in the Snow*, in which the locomotive's silhouette is distinct and the two headlights look like eyes peering ahead into the gloom of the wintry evening. Monet also worked on a series of paintings depicting the Gare Saint-Lazare in Paris in many different light and weather conditions, emphasizing the interplay between the hard angles of the station and the smudgy clouds of smoke that alternately conceal and reveal the people and objects in the station.

Though engineers could learn little about a train's technology from paintings by Joseph Turner and Claude Monet, art lovers could learn much about the emotions stirred by trains in the landscape.



THE GOODS TRAIN
CLAUDE MONET

THE TRAIN IN THE SNOW
CLAUDE MONET

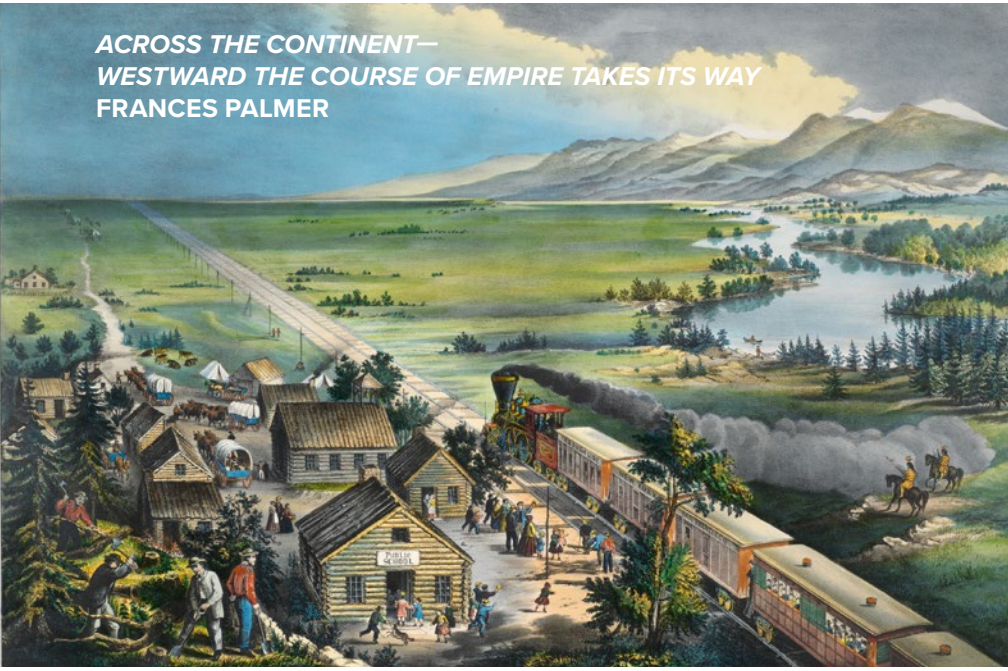
Most artists in Victorian Britain were more interested in the travelers and the way railways brought people of different social classes into direct contact with each other. William Powell Frith's 1862 painting *The Railway Station* is a masterpiece of the genre. It shows a large crowd at Paddington Station. Among the crowd, a wedding party is saying goodbye to newlyweds, a criminal is being arrested, and a cab driver is demanding a bigger tip than the one he received. One flustered family is hurrying to the train as a porter pushes a wagon with all their bags, and two boys are saying goodbye to their parents as they set off for boarding school. These people are different in appearance, social class, and purpose, but they all have one thing in common—they must catch the train and conform to its timetable.

FIRST CLASS—THE MEETING ... AND AT FIRST MEETING LOVED
ABRAHAM SOLOMON

Station settings were appealing, but Victorian painters also depicted passengers after they'd boarded their trains. Abraham Solomon's *First Class—The Meeting … and at First Meeting Loved*, from 1854, shows a young man meeting a beautiful young woman in a train compartment and seizing the chance to woo her while her father, seated to one side, is asleep. This picture was shown at the Royal Academy's annual exhibition, a major event in the London art world. Many viewers admired it, but others found it scandalous, as it suggested a slight impropriety of the kind made possible by the way railways permitted the mixing of previously unconnected people.

American artists, like their British counterparts, were quick to see the possibilities in railways. Frances Palmer's 1868 lithograph *Across the Continent—Westward the Course of Empire Takes Its Way* was completed a year before the first transcontinental railroad was finished. In the foreground stands a new community on the Great Plains. Pioneers are still cutting down trees for their log cabins, but already they've built a public school.

Cutting a strong diagonal across the frame is the straight line of a railroad, and on it stands a powerful locomotive that is preparing to set off across the plains. It can't be a coincidence that the plume of smoke pouring from its funnel is smothering two mounted Native Americans on a nearby bluff. They are literally being choked by the smoke of a new industrial world, the artist seems to say, and their time has come and gone. This picture is the perfect embodiment of Manifest Destiny, the idea that providence, or God, has chosen the Americans to dominate the entire continent and that there is a divine element to their progress west of the Mississippi.



ACROSS THE CONTINENT—WESTWARD THE COURSE OF EMPIRE TAKES ITS WAY
FRANCES PALMER

European artists were as fascinated by the new technology as their British and American counterparts. The German artist Paul Friedrich Meyerheim painted a series of four works in the 1870s showing the stages by which iron is mined from the earth, smelted in a furnace, and then transformed into a working steam engine. The fourth painting in the series, *Locomotive Construction*, shows designers poring over blueprints. Behind them, workmen complete a brass and iron locomotive inside a glass-roofed factory. The painting is a vision of purposeful and constructive progress.

20TH-CENTURY RAILWAY PAINTINGS

Western art was transformed in the early decades of the 20th century by the cubists, fauvists, futurists, and surrealists. Moving beyond conventional representation, they tried to express movement in paint and show multiple facets of an object at the same time. Umberto Boccioni, an Italian futurist, saw the possibilities of railways as a subject for this approach. He painted *States of Mind I: The Farewells* in 1911. One locomotive is heading straight for the viewer, while another one is running across the canvas. Red, white, and green swirls that dominate the canvas might be people dressed in flowing clothes, or they might be the smoke and steam that fill the station. The overall impression of energy and motion makes it a marvelous painting.

Once they were upstaged by cars and aircraft, railroads ceased to feel futuristic. Edward Hopper's 1929 painting *Railroad Sunset* radiates a feeling of isolation, showing a solitary railside signal box as the sun goes down. The painting bespeaks not excitement but the loneliness and alienation of industrial life.

By contrast, Thomas Hart Benton creates a sense of drama and almost of comedy in *Wreck of the Ol' 97*, from 1944. He depicts an incident that occurred in 1903. The scene is of a great locomotive an instant before it crashes at a crossing due to a broken rail. The driver of an approaching farm wagon pulls on the reins to stop his frightened, rearing horse. He and his companion flinch back, while the girl who had been riding in the wagon

bed is thrown out onto the road. The swirls of smoke, cloud, and even the foreground bushes are full of movement, and the painting somehow contrives to be humorous and warmhearted rather than tragic.

RAILWAY PHOTOGRAPHY

Two challenges confront anyone who wants to photograph a train. The first is that trains are much longer than they are high. To fit the entire train into the frame, the train has to be photographed from very far away, sacrificing

Creating a sense of movement in photographs was easier in the days of steam than it is with diesel and electric trains because the smoke streaming back from the chimney would convey the train's forward motion.

all detail, or else it has to be shown almost end on so that foreshortening can keep both locomotive and carriages in the picture. The second challenge is that much of the drama of trains comes from their movement, whereas photographs are still. The best railway photographs nevertheless impart the feeling of movement despite their static medium.

The standard solution to these challenges developed early, creating the classic train photo. The photographer adopts a low vantage point, near the track or even below track level, because looking up at the train emphasizes its grandeur. The train is approaching the camera so that its front is fully displayed. One side is shown obliquely, its features compressed because of the perspective, with carriages or wagons also visible behind. The perspective causes these elements to be sharply angled.

Moving beyond the classic train photo, railways offer many other aesthetic opportunities. First is the sheer straightness of the rails. Nature doesn't deal much in straight lines, except for the horizon, so there's an automatic contrast between the straightness of the track and the undulations of the landscape. Second, and closely related to straightness, is the fact that the rails are parallel. Looking at them as they recede into the distance creates a strong perspective effect. They convey a message of purpose and add an element of anticipation.

If the straightness of railways is exhilarating, parallel curves are even better. They interact with the landscape and show the trains to maximum advantage. Each carriage on a curve is presented at a slightly different angle to the camera. If the track is cambered for the bend, the train's angle away from the vertical adds another dramatic element.

In addition to straight lines and curves, the interplay of dramatic countryside with railways is another favorite theme. Steam rail photographers used to love Shap Fells in Cumbria, northwest England, where a long gradient forced the locomotives to work hard and pour out smoke against a dramatic mountainous backdrop.

And of course, the dirt that was inseparable from steam trains created an opportunity for great photographs. The award-winning photograph *The Spirit of Transportation* by King Ganaway, an African American photographer, was taken in 1918. The smoke and grime in the rail sheds create the seemingly divine shafts of light falling from above.

By the 1950s, when the era of steam locomotives was clearly coming to an end, they could no longer be depicted as excitingly new, but a generation of talented railway photographers learned how to suggest that they were excitingly old and that their twilight was something to mourn.

Colin Gifford depicted steam trains in the context of grimy working-class England, capturing scenes that were hazy with smoke and littered with rubbish. They often featured idle men gossiping or children playing street games. Gifford somehow communicated a sense of affection for urban decay. He realized that a good railway photograph should concentrate not solely on the train but on the whole environment, showing how buildings, landscape, people, and railway all interact.

O. Winston Link is to rural America what Gifford is to urban England. Link, a commercial photographer, realized in the mid-1950s that steam engines were being phased out everywhere. He seized the chance to photograph some of the last steam locomotives on the Norfolk and Western Railroad in rural Virginia, capturing them in small towns and lonely stations. His photographs are instantly recognizable as they are nearly all made at night and feature dramatic lighting.

READING

Kennedy, Ian, and Julian Treuherz. *The Railway: Art in an Age of Steam*. New Haven, CT: Yale University Press, 2008.

Rose, Ted. *In the Traces: Railroad Paintings of Ted Rose*. Bloomington: Indiana University Press, 2000.

Valkoinen, Christopher. *Railways: A History in Drawings*. London: Thames and Hudson, 2021.

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Railways in Cinema

Steam trains and moving pictures were a match made in heaven right from the start. The combination of the train's speed, visible moving parts, dramatic plumes of smoke and steam, and their rhythmic hissing and clanking all combine for maximum cinematic effect. Trains also created opportunities for strangers to meet, for relationships to blossom, and even for criminals to operate. This lecture examines a small sample of the hundreds of films that have made railways important to their settings, plots, and characters.

SILENT THRILLERS AND COMEDIES

One of the earliest films ever screened was *The Arrival of a Train at La Ciotat*, an 1896 French film made by the Lumière Brothers. According to some reports, early screenings of the film caused a sensation. So real and so unfamiliar was the spectacle that some viewers jumped from their seats in alarm.

A few years later, in 1903, American audiences were thrilled by *The Great Train Robbery*. It's an early silent classic, just 10 minutes long. In the first scene, two bandits hold up a station agent at gunpoint. Through a window, we see a train arriving as they tie him up so that he can't raise the alarm. Moments later, more bandits board the train.

They overpower the train driver and fireman. Detaching the engine from the train, they bring the passengers down to the track at gunpoint and fleece them of all valuables, shooting one man who tries to flee. Finally, they escape on the locomotive, which takes them back to their horses somewhere outside of town. Eventually, men from the community chase the bandits on horseback and shoot them down. Justice is restored, and the movie ends with another scene that scared early viewers, in which an armed man fires straight at the audience.

In the 1910s and 1920s, silent film directors also exploited the cheesy device of a fair maiden tied to the railway tracks by a sinister villain as the express train approaches, giving the hero an opportunity to free her just in time. The scene is played out in the 1913 film *Barney Oldfield's Race for a Life*, directed by Mack Sennett. In its most dramatic sequence, a locomotive is steaming toward the heroine as she is chained to the track. At the same time, a group of policemen are frantically rushing to save her on a railway handcart. A motorcar, driven by Barney Oldfield, who was an actual racing hero of the era, is also rushing to beat the train. The woman is lifted from the track by her two rescuers, and the train rushes by with less than a second to spare.

The comic possibilities of railway chases were fully explored in the silent era by Harold Lloyd, Mack Sennett, Buster Keaton, and many others. In *One Week*, from 1920, Keaton and his new bride build a house from a kit. Everything goes wrong, and the house ends up cockeyed and ugly. A hurricane-force wind makes it even worse, obliging the couple to drag what's left of it back to their original lot. Inevitably, they get stuck on a railroad

track, with a train coming. They cover their faces in dismay, but then the train, in a great comic touch, passes harmlessly on the adjacent track. The characters and audience alike breathe a sigh of relief, but then, just seconds later, a train going the other way smashes right through the house and reduces it to matchwood. It's a beautiful piece of comedy, skillfully manipulating viewers' emotions all the way.

Buster Keaton's masterpiece was *The General*, from 1926. It's a romantic comedy based on the true story of the Great Railroad Chase during the Civil War, when a group of Union guerrillas stole a Confederate train just north of Atlanta and tried to drive it to Chattanooga, sabotaging the track and telegraph behind them. Keaton plays the southern engineer who chased the stolen train to recover it.

Buster Keaton's decision to crash a real train into a river at the climax of *The General* made it the most expensive silent film ever made.

In the first half of the film, Keaton is the pursuer, struggling to catch up with the thieves and even trying to attack them with a mobile cannon. In the second half, he is the pursued, with Union trains and cavalrymen coming after him in strength. The climax of the film comes when a Union train attempts to cross a burning trestle bridge. The bridge collapses, and the train falls into the river. The Confederates counterattack, and Keaton's character is the hero of the hour. The Library of Congress has included it on the National Film Registry as a major cultural landmark.

Another classic of the 1920s was *The Iron Horse*, directed by John Ford. It's a fictionalized account of the first transcontinental railroad. Ford included scenes of men surveying the land and of gangs laying down track and hammering the spikes to hold the rails firm. He built two makeshift towns to represent North Platte, Nebraska, and Cheyenne, Wyoming. In one scene, as a rescue train rushes to help beleaguered workers, Ford embedded a camera between the rails so that the train could run over it—this was a revolutionary shot at the time, often imitated subsequently in railway movies.

The climax of *The Iron Horse* comes with the meeting of the two crews, Union Pacific and Central Pacific, at Promontory Summit, Utah. Using photographs from 1869, Ford was able to make a close approximation to the scene, with accurate positioning of men from the two sides, a swarming crowd in the foreground, speechmaking, toasting with open bottles, and even men clinging to the top of telegraph poles. Part of the film's success came from Ford depicting it as an act of national unification, not only of East and West but of the recently estranged North and South.

THE DRAMATIC FILMS OF ALFRED HITCHCOCK

Alfred Hitchcock was one of many directors to use the drama inherent in train journeys. In 1935, Hitchcock made *The 39 Steps*. Its hero, Richard Hannay, is wrongly suspected of murdering a mysterious young woman in London. Before dying, she gave him a map of a Scottish village, so he resolves to go there by train, hoping to save himself and unveil the real culprit. In one dramatic scene, he jumps out of the train, pursued by police, as it stands on the Forth Bridge, north of Edinburgh, one of the greatest railway structures in the whole of Britain.

Another Hitchcock film from the 1930s, *The Lady Vanishes*, is set almost entirely on board a train, somewhere in Europe at a moment of high political tension. An elderly woman disappears, and the young woman who had befriended her tries in vain to convince the other passengers that she really existed and that her disappearance is sinister. The audience knows she's telling the truth. The plot hinges on the idea that since the train hasn't stopped, she must still be on it, a recurrent theme in many subsequent train mysteries.

Hitchcock made a successful move from Britain to Hollywood in 1939 and continued to exploit the cinematic possibilities of railways. In his 1943 film, *Shadow of a Doubt*, a small-town family's happy life is upended by the visit of Uncle Charlie, who both arrives and leaves by train and who ultimately dies by falling from one train into the path of another. In the symbolism of this film, the railway threatens an ideal community by bringing in a menace from

outside. The immense cloud of black smoke pouring from the locomotive as Charlie comes to town is a metaphor for his evil character. Hitchcock said this was his favorite among all his films. Like *The General*, The Library of Congress has singled it out and placed it on the National Film Registry.

ROMANCE, DUTY, AND ADVENTURE

Romantic passion is the centerpiece of Britain's most famous railway movie, *Brief Encounter*, from 1945. Celia Johnson plays a middle-class housewife, mother of two young children, who makes weekly train trips to the nearby town to shop, meet friends, and see an occasional movie. The accidents of train travel introduce her to a charming doctor, played by Trevor Howard. He radiates a kind of erotic vitality that her easygoing husband can't match, and they are strongly attracted to each other. The starting and finishing times of their increasingly passionate meetings each week are determined by the train timetable. But they are too decent to act on their desire, and duty triumphs over passion.

The interplay of love, duty, and railways is also the theme of the 1952 American film *High Noon*. Gary Cooper plays Will Kane, a small-town marshal who has just been married. His bride is Grace Kelly. He knows that a train will come into town at midday carrying Frank Miller, a newly released criminal whom he had earlier sent to prison. He knows that Miller seeks vengeance. Despite pleas from his bride to flee with her, Kane has too much integrity and believes too strongly in the need for law and order to give in to her pleading.

The last 45 minutes of the film correspond with 45 minutes in the town as noon approaches. Miller's henchmen gather near the railroad depot water tower. Reliability and accurate timetables have turned from a blessing into a curse. Now, the train's punctuality brings on a violent confrontation.

Trains are symbols of freedom because they carry characters away to new adventures, but they're also symbols of restriction because they can never leave the tracks and they contain tight interior spaces where movement is limited.

The 1985 film *Runaway Train* is an action-adventure film about two vicious criminals, played by Jon Voight and Eric Roberts, escaping from a maximum security prison in Alaska in the dead of winter. After swimming an icy river, they come to a remote railroad yard and board a linked-up quartet of locomotives, hoping the train will carry them to freedom. The train has hardly set out, however, when the engineer suffers a heart attack and falls from the lead locomotive. At first, the prisoners don't realize that they're on a runaway train, but when it smashes into the caboose of another train and doesn't stop, they realize that something's seriously wrong. The authorities pursue relentlessly, and in the end, Jon Voight's character, Manny, determined never to be recaptured, uncouples the front engine from the others and roars off into the swirling snow and certain death.

READING

Ackroyd, Peter. *Alfred Hitchcock: A Brief Life*. New York: Anchor, 2017.

Curtis, James. *Buster Keaton: A Filmmaker's Life*. New York: Knopf, 2022.

Huntley, John. *Railways in the Cinema*. Shepperton: Ian Allen, 1969.

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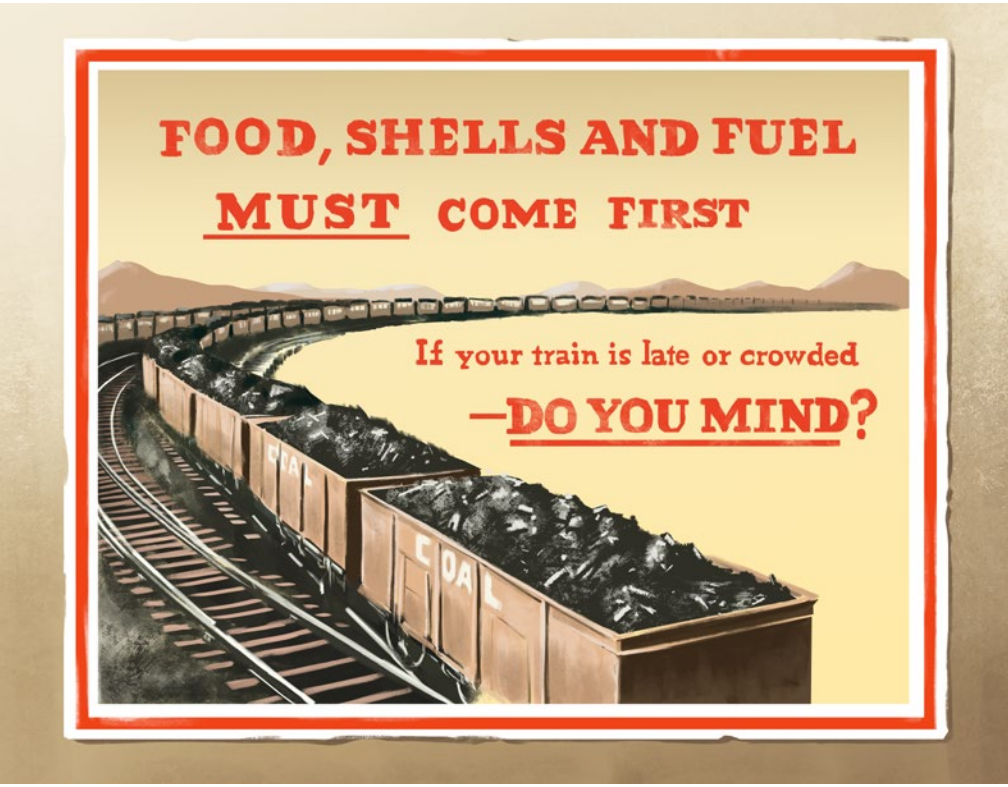
Nationalization and Decline in Britain

During World War II, demands on Britain's railways increased while maintenance decreased. The government had taken over running the railways and had also forced on them an arrangement to prevent windfall profits. As a result, the railways emerged from the war weaker rather than stronger. This lecture looks at Britain's railways during World War II and in the decades after, when a dramatic change in Britain's political landscape led to the nationalization of the whole system.



BRITAIN'S RAILWAYS DURING WORLD WAR II

Britain's railways worked hard during World War II. The German submarine threat made coastal shipping too dangerous, so railway companies took over its duties, in addition to serving an overstretched wartime economy. In the war years, they experienced an increase of nearly 500% in freight traffic by comparison with the Depression years of the 1930s. Every line and every train worked to the limit; there was little time for adequate maintenance, with the result that everything got older, shabbier, and more rickety.

Men who worked on the railways were exempted from military service because their civilian jobs were vital to the war effort. Many railwaymen volunteered to fight anyway, so the railways compensated by hiring more women than ever before.

To improve coordination during the war, a national committee appointed by the government took control from the four private companies that had been running Britain's railways since the early 1920s. Wartime railway posters declared that members of the public should no longer travel for pleasure and that seaside holiday resorts were being closed. Station name boards were taken down or painted over in 1940, in the hope that when the Germans invaded Britain, an event that seemed likely, they would not know where they were. The Germans never arrived, but British travelers were often left bewildered.

During the Blitz of late 1940 and early 1941, intense German bombardment damaged countless British stations and freight marshalling yards. Nearly 400 railway workers were killed on the job, and more than 2,000 were wounded. Despite the destruction, the British railway network was so dense that it was nearly always possible to compensate for damage on one route by diverting trains onto another. German bombing doctrine did not single out the railways, which were usually hit incidentally during raids on factories or dockyards. By contrast, Allied bombers flying missions from Britain over France and Germany did target enemy railways, especially in the buildup to D-Day.

Michael Williams's book *Steaming to Victory* does a good job of pointing out what a vital role Britain's railways played during the war. When the British army was evacuated from Dunkirk in May 1940, more than 300 extra trains had to be found to ferry them from the English Channel ports where they landed to barracks inland. Later, as the scale of the Anglo-American bombing campaign against Germany escalated, special trains had to bring the thousands of bombs and the tens of thousands of gallons of aviation fuel to

air bases in East Anglia. And finally, in the lead-up to the D-Day invasion, as more than 1 million American and Canadian troops arrived at British west coast ports, they, too, had to be moved by rail to camps in southern England.

As the end of the war neared, in early 1945, the four private companies' rights were restored, and the national committee commissioned artist Reginald Mayes to paint a poster symbolizing the railways' honorable wartime service. It showed a beautiful blue train with a Union Jack waving above it and the slogan "In War and Peace We Serve."

NATIONALIZATION AND THE BEECHING REPORT

In the general election of 1945, Winston Churchill's Conservative Party lost to Clement Attlee's Labour Party. Labour was a socialist party, and it pledged to abolish capitalism while spreading the benefits of industrialization more equitably. At the heart of the party's plan was the goal to nationalize all the major industries, including the railways.

Four companies had been operating as regional monopolies since the early 1920s: the LMS, the LNER, the Great Western Railway, and the Southern Railway. With Labour in control of Parliament, the Big Four were consolidated through the Transport Act of 1947, which turned them into a single nationally owned organization named British Railways. Each of the four regions retained its distinctive colors and traditions for the moment, but a steady process of homogenization began to reduce them.

British Railways continued to build steam locomotives through the 1940s and 1950s, and the sky over British cities remained dense with smoke. Designs of the 1950s were handsome, and these locomotives benefited in performance from the accumulated experience of more than a century. Particularly impressive were the Britannia class locomotives, built in the early 1950s and named after such historic figures as Oliver Cromwell, William Shakespeare, and Charles Dickens and such pseudohistoric figures as Robin Hood. The very last steam locomotive built for British Railways was completed in 1960 and named, aptly enough, *Evening Star*. It was the only locomotive scheduled

right from its birth to be preserved when steam workings ended. It survives as part of the permanent collection of the National Railway Museum in York, and it's a beauty.

The shift from steam to diesel and electric traction was one of the big postwar changes in British railway life. Equally important in those years was the growth of mass motorcar ownership, which threatened the future of passenger trains. In the same way, trucking began to cut into the share of internal trade carried by trains, a process intensified by heavy government spending on fast intercity roads. Affluence came more slowly to Britain after World War II than to America, but in 1957, Prime Minister Harold Macmillan was telling the truth when he said to the electorate, "You've never had it so good." Standards of living were rising, food rationing had ended, a growing percentage of families owned their own homes and cars, and real incomes were rising.

This was the context for a 1963 government report titled *The Reshaping of British Railways*—more commonly known as the Beeching report. Richard Beeching, a successful executive from the chemicals industry, was appointed head of the nationalized British Railways and undertook a major reorganization. His infamous report declared that about 5,000 miles of track around Britain should be closed, including more than 2,000 stations, because they could no longer justify themselves economically. These closures would entail the loss of about 67,000 jobs and leave many remote parts of Britain devoid of train service. He noted that, even though they were nationalized, railways should still aim to make a profit or at least break even to avoid becoming a burden on the nation's taxpayers.

The debate that followed the Beeching report showed that Britain's railways could not be thought of simply in economic terms, because powerful emotions were stirred by their place in British life. Despite the protests, Beeching's plan was enacted over the course of the 1960s and 1970s. Many of the main lines were improved, being electrified for faster, cleaner, and more efficient travel. As a result, a generation of trains was introduced that could run at 100 mph, shortening travel times between cities, which was the upside of the Beeching plan.

Also in the Beeching years, the movement to create a national railway museum gathered energy. London's Science Museum had been collecting works of exceptional technological significance since well before 1900, but a great deal of fascinating equipment had been scrapped for lack of space and funding. Finally, in 1975, on the 150th anniversary of the opening of the Stockton and Darlington Railway, the National Railway Museum opened its doors. British Railways had donated the buildings, and the museum enjoyed official support and government funding. It was significant for being the first national museum in Britain not sited in London. Instead, it was in York, adjacent to the main line between King's Cross in London and the Scottish capital of Edinburgh, and it has since become a mecca to railway enthusiasts from around the world.

One effect of nationalization was an end to the search for profits. Some lines could now be run at a loss if, in the government's view, they served an important role in local communications and in providing employment.

PRIVATIZATION RETURNS

The survival of many railway landmarks and the building of the National Railway Museum were matched by the political decision in the 1990s to privatize the system once more, after the decidedly mixed experience of nationalization. Privatization created a variety of new companies to run passenger railways in different areas of the country and to restore competitiveness and business principles to freight lines. Although the government did not surrender its right to regulation and oversight, privatization was intensely controversial and has remained so. Among its incidental effects were the creation of new names, colors, and liveries. Some old names, such as the Great Western Railway, Brunel's old company, were revived.

But no matter where you stand on this political issue, there's still a lot of pleasure to be found on Britain's railway system, and it remains a generally effective method of moving quickly from place to place. The express service from King's Cross in London to Edinburgh, for example, takes 4 hours and 30 minutes to cover 400 miles. There's a direct train every hour, and along the way you'll see Peterborough Cathedral and Durham Cathedral. You'll cross the spectacular high-level bridge at Newcastle-upon-Tyne, designed by the railway pioneer Robert Stephenson and completed in 1849, and the Royal Border Bridge at Berwick-upon-Tweed, completed in 1850 and opened by Queen Victoria as she journeyed north to her Scottish retreat at Balmoral. Services linking the other major cities are equally effective.

And, despite the harrowing effects of the Beeching plan, it's still possible to potter along quiet country train routes in Scotland, Wales, or East Anglia to rustic stations in the rural counties. One can still ride a train to Penzance in the extreme Southwest, just a few miles short of Land's End, and Thurso in the extreme Northeast of Scotland. Providing sheer scenic magnificence, the coastal route between Exeter and Penzance runs right along the waterfront beneath the cliffs at Dawlish and the fine views of the waterfront at the fishing port of Teignmouth. Another scenic journey is the mountain route from Settle to Carlisle in the Northwest of England, which goes over the great Ribblehead Viaduct. This line travels through the heart of the craggy and desolate Pennine Hills, passing Dent, the highest mainline railway station in Britain and one of the most picturesque.

READING

Jackson, Tanya, and Chris Green. *British Rail: The Nation's Railway*. Gloucestershire: The History Press, 2013.

Wolmar, Christian. *British Rail: The Making and Breaking of Our Trains*. London: Penguin, 2023.

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Railroads in Postwar America

This lecture looks at the challenges that the railroad industry faced following World War II. As passenger travel declined and freight railroading struggled to stay competitive, many railway companies were forced into mergers or bankruptcy. American railroading evolved from these difficult decades into something very different from its earlier days, but today it stands on much sturdier economic foundations.

CHALLENGES FOR PASSENGER RAILWAYS

American passenger railways were busier during World War II than ever before or since. They transported millions of men in military service to training camps and then to ports for overseas embarkation. Tens of thousands of families relocated to new cities by train for wartime job opportunities. Even Americans who owned cars were unable to use them because of gasoline rationing. Once the war was finished, however, railway passenger traffic declined sharply, never to recover. In the prolonged economic boom that ran from the late 1940s into the 1960s, most Americans bought automobiles for everyday travel. Government policy, notably the 1956 decision to build a nationwide interstate highway system, constituted a massive subsidy to the car industry.

Meanwhile, passenger aircraft offered much quicker travel times over long distances than railways. Government helped the airlines, too, by subsidizing airport construction. At first, railroad owners hoped that their spacious and luxurious trains would be able to hold their own on the long routes. These were the years in which they were switching from steam locomotives to diesel-electrics, which were cleaner and more efficient and required less time in the maintenance shops.

By the 1960s, railroads were petitioning the ICC to be allowed to give up passenger service altogether and to concentrate on freight, which alone offered them the hope of solvency. The agency had developed an elaborate set of regulations governing what services the railroads must provide and the amounts they could charge to passengers and shippers. Railroads found it difficult to compete with trucking companies, which could bargain with customers on a case-by-case basis to offer attractive rates.

Equally challenging was the power of organized labor. By the 1960s, most railroads were overstaffed because the unions fought against reducing the number of crew members on trains even when the new technology made some positions unnecessary. Too many employees escalated health insurance costs and pension liability.

Railroads that had dominated the industry for a century began to fail. Two of the great powers in the Northeast—the Pennsylvania Railroad and the New York Central—amalgamated to become Penn Central in 1968, only to go bankrupt 2 years later. The two companies were old rivals and operated according to different principles. They found it impossible to merge their systems into one efficient successor. Worse, the area they served, the Northeast, was becoming known as the Rust Belt as its heavy industrial base declined.

By the 1970s, no one doubted that American passenger trains were a losing proposition. However, to abandon passenger rail completely would worsen highway congestion, leave a vast infrastructure of track and stations unused, and throw thousands of people out of work. Perhaps it was time for America to emulate the rest of the world and accept the principle of government ownership and subsidy.

The collapse of Penn Central in 1970 was, at the time, the biggest bankruptcy in American history.

CONGRESS CREATES AMTRAK

In 1970, Congress passed legislation to create Amtrak, a passenger train service run by the federal government. It began operations the following year, taking over 20 of the 26 private companies that still ran passenger trains. The number of passenger trains per day was cut by more than half, and many services were discontinued altogether. Amtrak's managers selected the best locomotives and passenger cars from all over the nation.

Amtrak struggled partly from a lack of customers and partly from the fact that its trains ran on privately owned lines that prioritized freight. Amtrak trains would have to run at high speeds to be viable, but higher speeds require higher levels of track maintenance. To create the illusion that it might be profitable, the law did not require Amtrak to contribute to track maintenance costs—that burden fell on the freight railroads as a quid pro quo for being allowed to give up offering passenger services of their own.

Amtrak limped along through the 1970s and into the 1980s, too good to fail but not good enough to thrive. Its most successful line was the East Coast corridor linking Boston, New Haven, New York, Philadelphia, Baltimore, and Washington DC. The introduction of electrified *Acela* trains at the turn of the 21st century increased average speeds and shortened travel times.

FREIGHT RAILWAY TROUBLES

Freight railroading remained in private hands, but during the early 1970s, the federal government intervened to guide its development. One serious problem was that the system had too many lines. Many of them were underused, and there was a great deal of unnecessary duplication. Mergers were the answer. Some were parallel mergers between railroads that operated in the same area, which would enable them to close duplicate facilities, bring management under one roof, and close inefficient or underused lines. End-to-end mergers were designed to increase efficiency by extending the distance trains could travel on one company's tracks before having to switch.

The Regional Rail Reorganization Act, passed by Congress in 1973, created the United States Railway Association. Its purpose was to take over the operation of Penn Central and other bankrupt railroads, eliminate branch lines that lost money, improve the more lucrative sections, and try to restore profitability under the operating name of Conrail.

So grave was the perception of crisis that Conrail was allowed to ignore the usual ICC regulations, which had, after all, contributed to many railroad failures. Conrail ran for more than 20 years, eventually turning a modest profit. In 1998, its lines were divided between the two private juggernauts that had survived through a combination of aggressive mergers, efficient management, and shrewd planning. They were CSX and Norfolk Southern.

Surviving railroads succeeded largely because they were able to abandon unprofitable areas and partly because of deregulation. The crucial event came in 1980 when Congress passed the Staggers Rail Act. This was part of the broader movement toward deregulation of the American economy that began under President Carter and accelerated through the Reagan, Bush, and Clinton years. Deregulation gave the railroads more latitude of action. Now they could negotiate with shippers on a case-by-case basis, creating incentives and pricing competitively to win business away from truckers.

Today, freight railroading in North America is dominated by just seven big companies. The United States is dominated by CSX and Norfolk Southern in the East and by Union Pacific and by Burlington Northern Santa Fe in the West. They are complemented by Canadian Pacific north of the border; Canadian National, which also owns a route down the Mississippi valley to New Orleans; and the Kansas City Southern in the south-central US, which has strong rail links into Mexico.

Despite the consolidation of companies that took place between 1970 and 1998, it's still impossible for a freight car to cross the United States from coast to coast on the lines of the same company.

FREIGHT RAILWAY REVIVAL

While the giant companies were taking shape, railroading around the world began to enjoy a renewed respectability. Growing concern about motor vehicle congestion and global warming diminished the attraction of trucking. By contrast, the phenomenal efficiency of railways meant that they could depict themselves as the "greenest" bulk transport technology on the planet. In terms of fossil fuels burned per ton-mile of traffic, this was unquestionably true.

Environmental considerations played a role in one of the great growth areas of railroading after 1970. The Clean Air Act of that year required industries that burned coal to reduce their emission of sulfur compounds. Coal from the Appalachian states of Pennsylvania, West Virginia, and Kentucky had a heavy sulfur content, which meant that power stations, which were the biggest users, would have had to install expensive scrubbers on their smokestacks or seek an alternative source of coal.

Large reserves of accessible low-sulfur coal were available in the remote Powder River Basin (PRB) of northeastern Wyoming and southeastern Montana. The PRB suddenly became attractive even though coal from its strip mines would have to be carried across the country to its ultimate users. Rail was the obvious solution, but the area was not well provided with lines. The Burlington Northern Railroad had a small secondary line near the coalfield, but it would have to be extensively rebuilt to withstand the pounding of heavy coal trains.

Burlington's management took the risk and invested heavily. Coal deliveries from the PRB to the rest of the country were in full swing by 1984. Their profitability soon drew the attention of other western railroads, including the Union Pacific, which invested billions of dollars to create a link between the PRB and its hubs at Council Bluffs and on the West Coast. Customers could therefore benefit from competition between the two companies to keep transport costs relatively low.

PRB coal was one of the two newcomers that facilitated the American railroad revival. The other newcomer was shipping containers, the idea for which germinated in the 1950s. A North Carolina trucker, Malcolm McLean, was exasperated by the situation at American dockyards, where cargo had

to be unloaded from trucks and then laboriously reloaded onto ships by longshoremen and stevedores. The process was slow and led to losses for shippers. To circumvent this situation, McLean bought and modified an old oil tanker ship, the *Ideal X*. He loaded 58 steel containers on board one day in 1956 and then sailed it from New Jersey to Houston. The containers were unloaded at the docks in Houston and trucked off to their destinations without their contents being touched by any dockyard workers.

It would take 3 decades for containers to achieve dominance. Vested interests on the dockyards had to be overcome in the face of intense political opposition, and the necessary container terminals had to be established. The size of containers had to be standardized so that they could stack neatly and be locked one on top of another. Today's largest container ships can carry more than 10,000 full-size containers.

Their rise also coincided with the rise of the "Asian tigers": Japan, South Korea, Taiwan, Hong Kong, and Singapore, industrial producers that exported to the United States. The fact that ships from Asia arrived in West Coast ports but carried goods that would mostly be consumed east of the Mississippi River created another expansion opportunity for the railroads. Today, intermodal traffic is the beating heart of world trade.

READING

Loving, Rush, Jr. *The Men Who Loved Trains: The Story of Men Who Battled Greed to Save an Ailing Industry*. Bloomington: Indiana University Press, 2006.

McClellan, Jim. *My Life with Trains: Memoir of a Railroader*. Bloomington: Indiana University Press, 2017.

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High-Speed Trains in Europe and Asia

When intercity distances are great, as they often are in the United States, traveling by air makes sense. But inside Japan, France, Germany, and Italy, any two points can be covered in a long day's train ride, so it's not surprising that high-speed passenger trains developed there first. This lecture explores the evolution of high-speed trains that intended to capture those intermediate distances—too long for a quick car trip but too short for a plane. It also looks at several possibilities for the future of train travel.

JAPAN'S BULLET TRAINS

For Japan, the Shinkansen, or bullet train, was partly a practical response to intercity distances, but the bullet trains were also a national prestige project, part of Japan's recovery after World War II. A brilliant technologist, Hideo Shima, and a talented political veteran, Shinji Sogō, partnered to create the first line. The Shinkansen's debut in October 1964 coincided with Japan's hosting of the Olympic Games. Some events were held at Osaka, 300 miles from Tokyo, which enabled the government to showcase the trains as they carried athletes, journalists, and dignitaries between the two sites at 120 mph.

Dedicated high-speed lines were needed because, as speeds increased, curves had to be reduced. On the preexisting lines, the bullet trains would not have been able to run at full speed. The success and profitability of the first line, despite higher-than-expected construction costs, led to the creation of many more, which today cover nearly 2,000 miles and run at speeds of up to 200 mph.

The early trains themselves looked futuristic, coinciding as they did with the first generation of space travel. Owing a lot to aircraft design, they were heavily streamlined and, unlike steam locomotives, had no visible moving parts.

Noise was one of the problems the engineers had to confront. When the trains burst out of tunnels, they created shock waves that sounded like sonic booms to nearby residents. Later generations of the trains reduced noise by redesigning the front of the locomotives, borrowing insights from the aerodynamics of birds—a process called biomimicry. Passengers also reported that when their train passed another one inside a tunnel, they felt sharp pains in their ears due to the sudden change in air pressure. The designers' response was to pressurize the carriages, another way in which the Shinkansen resembled aircraft.

FRANCE'S TGVS AND SPAIN'S AVES

In Europe, France was the pioneer in the development of very fast passenger trains. It had established the world railway speed record of 206 mph in 1955, but the record-breaking run damaged the track and demonstrated that more sophisticated levels of engineering would be needed. The first French Train à Grande Vitesse (TGV), meaning "high-speed train," began service between Paris and Lyon in 1981. France built a separate dedicated line that rejoined the conventional tracks close to each of its terminal points.

Spain also invested heavily in high-speed trains, known there as AVEs, after joining the European Economic Community (EEC) in 1986. Because Spain was a relatively poor country, it received a windfall of EEC funding and plowed much of it into fast trains. The first Alta Velocidad Española (AVE) line, between Madrid and Seville, went into operation in 1992.

Opponents of the AVE system argued that it burdened taxpayers and would likely increase the influence of the central government in Madrid over the provinces. For Catalonia and the Basque Country, which have struggled for centuries to keep and increase their autonomy, this was a sinister prospect.

The French national rail company discovered that drivers going 200 mph were unable to read trackside signal lights, so they created an electronic system that fed information about speed and conditions to the driver in his cab.

CHINA'S HIGH-SPEED RAILWAYS

Boldest of all investors in high-speed trains was China. The Chinese Revolution that brought Mao Zedong to power in 1949 was a mixed blessing to the Chinese people. It ended a period of internal war and Japanese occupation, but it also brought insane ideological projects, such as the Great Leap Forward, which caused widespread famine and millions of deaths from starvation, and the Cultural Revolution, which led to mass repression and economic chaos.

After Mao's death in 1976, Chinese leaders began to act more rationally, introducing a form of state-regulated capitalism and creating entrepreneurial opportunities. The economy boomed, life expectancy increased, and China rapidly gained in prestige, wealth, and power. Railways were integral to this expansion, and mileage grew steadily in the 1980s and 1990s.

China's government authorized the first high-speed railways in 2004, running north to south and east to west. The first dedicated line opened between Beijing and Tianjin in 2008, timed to coincide with the Beijing Olympic Games. The government then announced an ambitious plan to open 42 more dedicated high-speed lines in the next 3 years.

Determination to get the lines finished on schedule led to some dangerous corner cutting. Forty people died at Wenzhou in 2011, and nearly 200 more were injured when, during a thunderstorm, a train lost power and stopped. Warning signals failed, and the next train coming smashed into it. A 6-mile

section of line between Wuhan and Yichang collapsed the following year, closing the line for months. Investigation of both incidents revealed a combination of bribery, embezzlement, failure to use suitable materials, and neglect of safety precautions, all of which had jeopardized passengers.

Today, more than two-thirds of all the world's high-speed railways are in China, and the building of a dense nationwide network continues. It had 40,000 miles by 2021, with 70,000 scheduled by 2035.

COMPLETION OF THE CHANNEL TUNNEL

Britain was slow to join the high-speed revolution, but it did partner with France in fulfilling a project that had been imagined for more than a century: the building of a railway tunnel beneath the English Channel so that passengers could take direct trains between London and continental cities, such as Paris and Brussels.

The first attempt at a channel tunnel got underway in 1881 with preliminary drilling from both sides. But the project came to a stop because of intense public opposition in Britain over suspicions of a French invasion plot. Finally, in 1964, the two governments agreed that a tunnel should be built. Even then, political squabbles, cost increases, and uncertainty about whether Britain wanted to become part of a united Europe led to further delays.

In Britain, environmentalists generally support rail over road, but some have pointed out that a train going 200 mph requires more than twice as much energy as one going 125 mph, so the carbon-emissions benefit diminishes as trains get faster.

Work finally began in 1988. Electric railway was chosen over the option of a road tunnel because of concerns about dealing with fumes, the difficulty of responding to accidents, and the hazard of terrorism. Cost overruns pushed up the price from an initial estimate of $2.5 billion to more than $4.5 billion. Fifteen thousand men using 10 boring machines worked on the project, which was eventually 31 miles long, including 24 miles under the sea.

The two work crews met in 1990, with the English and French tunnels almost perfectly aligned, and the whole project was completed and opened in 1994. It became possible to travel from London to Paris in about 2 hours and 20 minutes and from London to Brussels in less than 2 hours. A new dedicated line from the English end of the tunnel led trains, running faster than 150 mph, to St. Pancras station in London, which was extensively modified to become the Eurostar terminal.

RAILWAYS OF THE FUTURE

Although high-speed trains in Europe and Asia have continued to get faster, there is a limit beyond which they probably can't go because of the friction of wheels on rails, the vibration, the metal fatigue, and the fact that each increase in speed requires a lot more energy. A characteristic called hunting oscillation means that a train could derail itself at high speed even from a flat straight track. The logical next step is to have a railway without wheels, which sounds like a contradiction in terms but already exists.

The first possibility along these lines was hovertrains. The French government funded experiments with them in the 1970s and reached what was then an all-time train speed record of 267 mph in 1974. The elevated track, on concrete posts, was an inverted letter T; the train hovered a quarter of an inch above it on a cushion of very high-pressure air and was powered by a jet engine. The hovertrain was noisy and took a lot of fuel to operate, with the result that it did not survive the oil crises and economic downturn of the late 1970s.

A second possibility uses a technology called maglev, which is an abbreviation of *magnetic levitation*. The effect of holding two magnets close to each other and feeling the repulsion is well known. That's the basis for this technology. The magnetic repulsion lifts the train while gravity continues to force it down. In effect, it hovers about an inch off the ground. Other magnets move the train forward under the same principle. It doesn't have wheels or rails, just a guide track, which takes the form of a concrete trough.

The first maglev patents were granted as far back as 1912. A maglev train ran in the 1980s and 1990s in Birmingham, England, but only over a short distance of less than a mile. In China, a high-speed maglev system went into service in 2004, with a line that runs faster than 250 mph between Shanghai and its airport. Japan is also building a 300-mile intercity maglev train that will run between Tokyo and Osaka.

The hyperloop line planned to run between Dubai and Abu Dhabi in the United Arab Emirates would shorten the journey between those two cities from 2 hours by car to just 12 minutes by train.

A third futuristic possibility is hyperloop. This technology involves enclosing a maglev vehicle in a transparent pipe and then creating a vacuum so that the train moves without air resistance. Enthusiasts claim that it will eventually run at 700 mph and that renewable energy sources like wind and solar will be able to provide its comparatively low energy demands.

READING

Donovan, Sandra. *The Channel Tunnel*. Minneapolis, MN: Lerner, 2003.

Hood, Christopher. *Shinkansen: From Bullet Train to Symbol of Modern Japan*. London: Routledge, 2006.

Hughes, Murray. *The Second Age of Rail: A History of High-Speed Trains*. Stroud: The History Press, 2020.

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Nostalgia and Railway Preservation in Britain

The bureaucrats who ran British Railways in the 1960s knew that the end of steam operations would lead to a wave of nostalgia. What they failed to foresee was how steam railways would become a central element of Britain's heritage industry, almost on a par with the nation's monarchy, castles, stately homes, and gardens. Today, Britain is honeycombed with places dedicated to the sentimental veneration of railways. This lecture looks at some of the preserved railways and museums that are keeping steam fever alive for enthusiasts and future generations.

PRESERVATION SOCIETIES IN BRITAIN

Around 150 preservation societies run old trains, many of them steam powered, on lengths of otherwise disused track. For financial support, they all rely on contributions from enthusiasts, occasional grants from local government and historical associations, and sales of tickets to tourists.

Among the best known of Britain's preserved steam engines is *Olton Hall*, made famous as the deep-red locomotive that pulls the *Hogwarts Express* in the Harry Potter films.

Normally, the best way to preserve something is to shelter it behind glass and make no demands on it. But to railway preservation societies, the ideal is to have the trains running, even though doing so leads to damage and deterioration. Hundred-year-old locomotives have been reconditioned so often that hardly any of their original components remain.

Where did all the steam locomotives come from? Most were from a scrapyard at Barry, in South Wales, where British Railways sent 297 of them to be cut up in the late 1960s. The yard's owners, the Woodham brothers, found them difficult to dismantle and left them rusting on disused sidings, choosing instead to cut up old freight wagons, a more straightforward job. To their surprise, the scrapyard became a pilgrimage site for aspiring preservationists, many of whom put down deposits on the engines they intended to buy as soon as they had raised the funds. The Woodham brothers eventually sold more than 200 of these engines, 151 of which have been restored to working order.

PRESERVATION LINES

Britain's first steam heritage railway was the narrow-gauge Talyllyn Railway, in central Wales, begun in 1951. The narrow-gauge Ffestiniog Railway followed shortly thereafter, running from a slate quarry town in the Welsh hills down to the coast at Porthmadog. Among its delights are some very unusual double Fairlie locomotives that have two boilers and a cab in the middle.

An even narrower gauge of just 15 inches is used by the Ravenglass and Eskdale Railway in the English Lake District. It's a miniature railway, with engines less than one-third of the size of full-size locomotives. They are still powerful enough to pull long trains through an extremely beautiful mountain landscape. Originally built in the 1870s as a line to bring iron ore from a mountain quarry to the coast, the Ravenglass and Eskdale reopened in the early 1960s for tourists and has been chugging back and forth ever since.

Britain's first standard-gauge preservation line was the Bluebell Railway, in Sussex, south of London, which opened in 1960, 8 years before steam service on the main lines ended. Its head start enabled it to gather more than 30 steam locomotives, many of which are still in working order.

After a brief period of banning steam engines completely, British Railways realized that this policy was unpopular and relented. The first mainline preservation venture was with a locomotive called *Flying Scotsman*—not to be confused with the London-to-Edinburgh train of the same name. Built in 1923, *Flying Scotsman* was scheduled for scrap in 1963 after having traveled more than 2 million miles during its 40-year working life. Alan Pegler, a rich businessman, stepped in and bought it for £3,500. He then ran it on tours with the cooperation of British Railways.

Even before other steam locomotives disappeared, *Flying Scotsman* drew large crowds, partly because it was the first steam engine in Britain to have achieved the speed of 100 mph. Pegler took it to America in 1969, where it toured the country, but by the time it reached San Francisco, Pegler himself had run out of money and was forced to declare bankruptcy. Another businessman, William McAlpine, stepped in to rescue it. He shipped it back through the Panama Canal, and it resumed operations in Britain. Later, it toured Australia. McAlpine and then a third owner, Tony Marchington, also ran into financial trouble until, in 2004, the National Railway Museum bought and restored it yet again.

TALYLLYN RAILWAY AT NANT GWERNOL

About 30 other steam locomotives still ply the main lines, carrying enthusiasts around the country. Run mostly by a charter company, West Coast Railways, they are closely monitored by government because steam operations are hazardous. Favored routes are the most picturesque, notably the Settle–Carlisle line in the Pennine Hills, which takes riders over the Ribblehead Viaduct, a spectacular bridge built in 1870 on one of the most beloved but least logical lines in the country.

The last British Railways steamer, *Evening Star*, was completed in 1960. But in 2008, a new locomotive appeared, numbered 60163. Named *Tornado*, it would have been the next locomotive of its class to be built if steam engine production had not been suspended. A group called the A1 Steam Locomotive Trust raised funds in a public appeal, beginning in 1990, and built the locomotive at Darlington. It has enjoyed a blaze of favorable publicity, culminating in its achievement of 100 mph in 2017. So successful has this venture been that its makers are now busy building a second engine and have plans for a third.

NATIONAL RAILWAY MUSEUM IN YORK

The best place to get a comprehensive sense of railway history is the National Railway Museum (NRM) in York. The NRM is the home of the National Collection, a group of the most technically important vehicles in British railway history, but it also showcases some of the best locomotives from around the world, including an early Japanese bullet train and one of the last generation of Chinese steam freight engines.

The museum features famous British railway locomotives like *Mallard*, which holds the world record for steam speed, and the streamlined *Duchess of Hamilton*. Far less famous but still important are the ugly, scratched, and dingy engine and wagon that came to York when work on the Channel Tunnel was completed. The museum decided not to restore them to mint condition but to emphasize their function as hard workers in a tough environment. Nearby is a Eurostar train of the kind that now goes back and forth under the English Channel and a concrete section of the Channel Tunnel itself.

An easy walk from York station, the National Railway Museum is generally reckoned to be the world's best railway museum.

Also present at York is George and Robert Stephenson's original *Rocket*, battered and antiquated but standing alone and elevated in a shrine-like area under dramatic lighting. There is also a bright yellow replica of it as it would have appeared at the time of its triumph in the Rainhill trials of 1829. The whole place honors the Stephensons as founding fathers.

The NRM also has a second collection at Shildon, in a building named Locomotion. It displays more of the National Collection, including the world's fastest diesel locomotive, the *InterCity 125*—an engine that achieved 148 mph in 1987.

Thomas the Tank Engine was created by Wilbert Awdry and debuted in 1946 in the second of his 26 books for children. Awdry modeled *Thomas* and the other engines in the series on actual locomotives then current on Britain's railways but set his stories on an imaginary island off the coast of Britain. When the TV series *Thomas & Friends* first aired in 1984, these anthropomorphized engines became world famous. The Colorado Railroad Museum, just outside Denver, has a full-size *Thomas* who comes out to lead trains on a few special weekends every year.

MUSEUMS IN SWINDON, DIDCOT, AND LONDON

Swindon's STEAM—Museum of the Great Western Railway, about 70 miles west of London, does the best job of emphasizing not just the trains but also the people who built and maintained them. Housed in the old carriage and wagon works of the Great Western Railway, the museum includes life-size models of men and women at work, including two women cleaning out the boiler of a steam locomotive, in tribute to women's service in the works during World War II.

In Swindon, it's also possible to walk into an inspection pit underneath a locomotive. Such a job could not have been pleasant when the pit was full of choking smoke, ash, and oil but is fine when everything is spotless. Swindon also displays mint-condition locomotives and carriages—the brothers and sisters of the Great Western working locomotives at Didcot.

Didcot is a junction, where a spur from Isambard Brunel's Great Western line between Paddington and Bristol branches off to the northwest, carrying trains to Oxford and Birmingham. The Didcot Railway Centre, in Oxfordshire, is run by the Great Western Society and housed in old workshops and sidings. The museum sits between the main line and the Oxford line, giving visitors the chance to appreciate today's trains side by side with those of the last 2 centuries.

Visitors enter the museum through the tunnel under Didcot station's platforms. At one end of the museum is a shed containing *Iron Duke* and *Firefly*, working replicas of Brunel's 7-foot-gauge locomotives from the 1840s. The museum owns about 30 Great Western steam locomotives of the early 20th century, all of which were built to similar designs, giving them (at least to aficionados) an instantly recognizable Great Western look. Best of all were the Castle and King classes, each of which is represented: *King Edward II* is particularly splendid in blue livery. The line is only about half a mile long, so it can't get up to full speed, but even at 15 or 20 mph one gets a sense of its power and dignity.

Finally, the Science Museum in London's Kensington district includes railway exhibits in the context of the other inventions of their times. Visitors reach *Puffing Billy*, the oldest surviving original locomotive in the world, after passing a series of stationary steam engines of the kind that predated it in the 18th and early 19th centuries. The Science Museum's exhibits give one a lively sense of how the railways developed as an integral part of the Industrial Revolution.

READING

Brown, Jonathan. *The Railway Preservation Revolution: A History of Britain's Heritage Railways*. Yorkshire: Pen & Sword Transport, 2017.

Dunstone, Denis. *For the Love of Trains: The Story of British Tram and Railway Preservation*. London: Ian Allen, 2008.

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Railroad Nostalgia in America

Steam locomotives were phased out sooner in the United States than in Britain, and the generation that can remember riding them has almost completely passed from the scene. Even so, the steam experience has been lovingly preserved in the form of many excellent museums and heritage railways. This lecture highlights the preservation efforts in two states: Pennsylvania in the East and Colorado in the West.

PENNSYLVANIA'S MUSEUMS AND RAILROADS

Pennsylvania got rich on coal, iron, and steel, and the history of its railways is intertwined with the history of those industries. At Bethlehem, for example, a line of stupendous blast furnaces creates a dramatic skyline. The area is preserved as a historic district and includes an excellent industrial museum that's full of intricate stationary steam engines, while the rails adjacent to the factories are still hard at work.

The same is true in Altoona, which was founded as a railroad town and where tracks still roar with Norfolk Southern trains. The Railroaders Memorial Museum there recalls not just the hardware but the men and women who worked on it. Altoona and Bethlehem must have been ghastly places to work when the air was full of sulfurous smoke; now, it's impossible to miss the note of elegy in the way their history is presented.

Pennsylvania has two big collections of old locomotives. The first is Steamtown National Historic Site at Scranton, another town with a long railroad history. Originally belonging to the Delaware, Lackawanna and Western Railroad, the site is now owned and run by the National Park Service. The locomotives are displayed to good effect at the roundhouse, the distinctive locomotive storage building of the steam age, whose centerpiece was a turntable that could deliver each engine in turn to its berth.

In the surviving section of the original roundhouse, one steam locomotive has been sliced open longways so that visitors can get a good idea of how it works. Other locomotives in various stages of restoration give a hint of what these workshops were like in their active days, minus the choking forges and furnaces.

On an elevated walkway that leads out of the museum and into a nearby mall, one can look down on the moldering hulks of numerous locomotives and passenger cars. Each has deteriorated in its own special way. To gaze on these wrecks is to realize what a lot of work it took to keep the trains looking sharp in their working days and what huge labor is involved in restoring them to their former glory.

A highlight of Steamtown is a Union Pacific *Big Boy*, the biggest steam locomotive in history. Built in the 1940s to carry long freight trains over the steep gradients of Utah and Wyoming, the *Big Boy* is half engineering marvel and half monstrosity. It's so long that it's difficult to photograph.

Pennsylvania's second great collection is at Strasburg, in Amish country. Strasburg is home to a steam-driven heritage railroad and to the National Toy Train Museum. Best of all, Strasburg is home to the Railroad Museum of Pennsylvania. Enclosed in a spacious, high-roofed building, this museum houses locomotives and cars spanning the entire history of the railroad era, with a strong emphasis on the once-dominant Pennsylvania Railroad. At one extreme, there's a replica of the locomotive *John Bull*, an English-built engine from the 1830s that came across the Atlantic in pieces to be assembled on the Camden and Amboy Railroad. At the other extreme are examples of the diesel and electric locomotives that were still at work as the new millennium began.

One electric locomotive from 1943 was designed by Raymond Loewy, probably the most influential industrial designer in American history. The locomotive looks old now, but that's because it looked so new then, with its sleek curves, emphasized by the cat's whisker pattern of yellow lines that bring to life the lines of its glossy black body.

An overhead catwalk lets one look down on the whole collection, and from this vantage point, one realizes the aesthetic advantage of having it all set on a gentle curve rather than parallel straight lines. The freight and passenger cars are as interesting as the locomotives. An experimental all-steel car from 1906 is on display, with the explanation that it marked a great improvement in passenger safety, being more rigid in crashes and less likely to catch fire. The change was only gradual, however, because many railroads continued to use their old wooden rolling stock well into the 20th century.

Pennsylvania has two awe-inspiring railway bridges. The Tunkhannock Viaduct, completed in 1915, was the biggest concrete bridge in the world, and it's still a marvel today. Farther north stands the Starrucca Viaduct. Built of stone and completed in 1848, it has been carrying trains ever since.

COLORADO'S MUSEUMS AND RAILROADS

Colorado, like Pennsylvania, is mountainous, but it's higher and drier and was far less accessible for much of American history. It began to thrive in 1858 with the Pikes Peak gold rush near current-day Denver but remained very hard to reach until the first railroads arrived in 1870, one linking Denver to Kansas City, Missouri, and another linking Denver to Cheyenne, Wyoming. Surveyors and engineers then had to meet the challenge of laying tracks to mines high up in the Rockies. Many of Colorado's lines were narrow-gauge, partly for reasons of economy but mainly to permit tight curves in the broken landscape. Today, Colorado has an array of steam-driven narrow-gauge rides and the most dramatic scenic canyon ride in the nation.

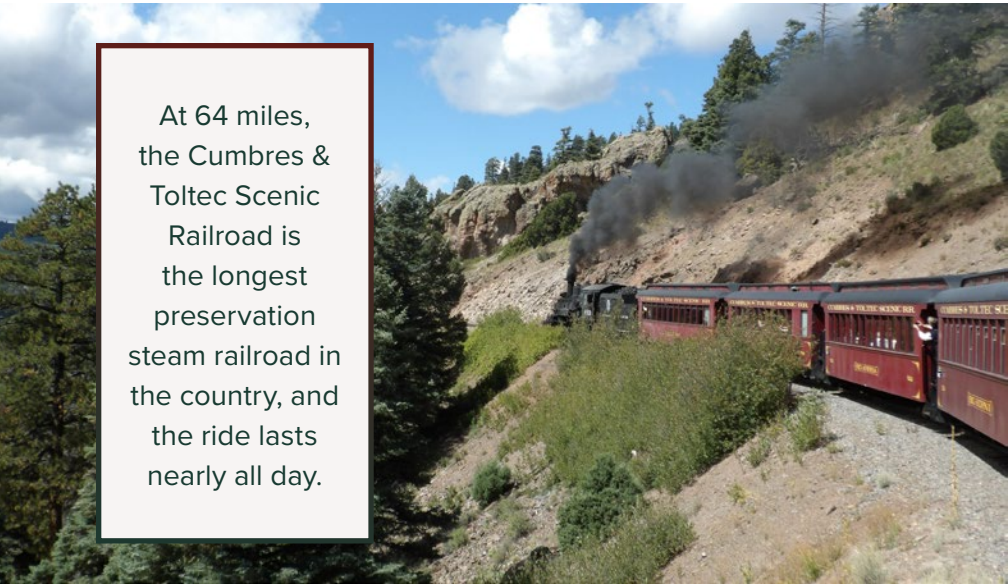
Start at the Colorado Railroad Museum in Golden, just west of Denver. Situated where the Great Plains end and the Front Range of the Rocky Mountains begins, it has a superb collection of locomotives and passenger cars. Much of the collection comes from the Denver and Rio Grande Western Railroad, also known as the Rio Grande, whose lines linked Denver and Pueblo to the high mountain communities of Leadville, Silverton, Ouray, and Creede.

Thirty-five miles west of Golden and more than 3,000 feet higher into the mountains stands the Georgetown Loop Railroad, which includes another of the most picturesque railway bridges in the country, a high curving steel gantry that carries slow, chuffing narrow-gauge steam trains pulling open passenger cars. After crossing the bridge, trains then describe a full circle on rails through the woods before passing under the same bridge a few minutes later. The Georgetown Loop line is about 5 miles long, but it links a pair of old mining towns that are only 2 miles apart, the extra length being necessary because of an altitude change of 640 feet, which it achieves with the help of the loop and several hairpin bends. The line was built in the late 1870s to carry silver ore from the region's mines. The trains today stop halfway along their route to let passengers alight and explore one of the abandoned mines.

About 120 miles southeast of Georgetown is Cañon City, home of the Royal Gorge Route Railroad. Here, the train, pulled by glossy orange-and-black diesels, enters one of the narrowest and steepest-sided canyons ever penetrated by a railway. The Santa Fe Railway and the Rio Grande fought over access to Royal Gorge in the late 1870s, since it provided the best route to Leadville, the scene of a recent silver discovery, but was only wide enough for one track, if that. Gangs of thugs hired by the two companies exchanged insults, gunshots, and rocks in 1879, but a court decision confirmed that the Rio Grande could build its line there.

Today, it's possible to board the train in Cañon City and ride into the gorge, whose walls close in from either side and become steadily higher and closer together with each passing mile. The Arkansas River rushes beside the line, which, in places, sits precariously on a rock shelf and at one point is suspended from two sets of angled girders embedded in the canyon walls. The high point comes as the train passes under a suspension bridge that crosses the gorge almost 1,000 feet overhead.

Best of all the Colorado railways is perhaps the Cumbres & Toltec Scenic Railroad, another narrow-gauge remnant of the Rio Grande. At around 7,500 feet, it runs between the little towns of Antonito, Colorado, and Chama, New Mexico, and is named for the Cumbres Pass and Toltec Gorge, two of its distinctive points. The train gradually gains height on a long series of twists and turns and offers spectacular views over the surrounding country. Highlights include two tunnels; Windy Point, a high shelf blasted out of the mountains; and an exhilarating descent into a remote valley.



At 64 miles, the Cumbres & Toltec Scenic Railroad is the longest preservation steam railroad in the country, and the ride lasts nearly all day.

The Durango & Silverton Narrow Gauge Railroad has much in common with the Cumbres & Toltec. They are both 3-foot narrow-gauge lines and were, until 1968, parts of the same system. The Rio Grande ran from Chama to Durango, which is 6,500 feet above sea level, at which point a spur line, built in 1880 and 1881, headed north to the mining town of Silverton, more than 9,000 feet above sea level. A combination of steam and diesel engines works this line today. The Durango & Silverton sets off from a station in

downtown Durango and travels on a long, straight track. This section lulls riders into a false sense of security because, at the end of the valley, the line suddenly begins climbing into the mountains on steep switchbacks. Its showpiece comes at a breathtaking right-hand bend above the Animas Canyon. The train emerges from a jagged rock cutting and then creeps along a narrow shelf while the view into the canyon brings on fits of vertigo.

Among its many mountains, Colorado contains 53 that are higher than 14,000 feet. The most famous among them is Pikes Peak, near Colorado Springs, which is the highest point in the dramatic Front Range. Since 1891, the easiest way to get to the summit has been on the Manitou and Pikes Peak Cog Railway, a rack-and-pinion railway that enables the trains to climb more steeply than would be possible on conventional tracks. Its technology has been updated several times, and it now consists of smooth, comfortable diesel railcars imported from Switzerland, the home of rack-and-pinion railroading.

The many wonderful museums in other states include the California State Railroad Museum in Sacramento, the Tennessee Valley Railroad in Chattanooga, and the Illinois Railway Museum in Union, northwest of Chicago. They are testaments to the dedication of the many societies across the country that keep generations connected to the past. All these societies are sources of inspiration, and collectively they offer the reassurance that steam railways, in America as in Britain, are here to stay.

READING

Morrison, Patrick. *The Railroad Museum of Pennsylvania in Pictures*. Atglen, PA: Schiffer, 2023.

Wilson, Spencer, and Wes Pfarner. *Saving the Cumbres and Toltec Scenic Railroad*. Charleston, SC: The History Press, 2012.

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Enjoying Europe's Railway Heritage

Passenger railways are alive and well in Europe—fast, efficient, and central to the European Union's massive economy. They are a superior alternative to air travel for any journey less than 500 miles because they take passengers rapidly from one city center to another without time-consuming security lines. The border arrangements of the European Union countries mean that trains cross national boundaries without stopping. Most European countries recognize the importance of railways in their past as well as their present and have found ways to commemorate and celebrate them.

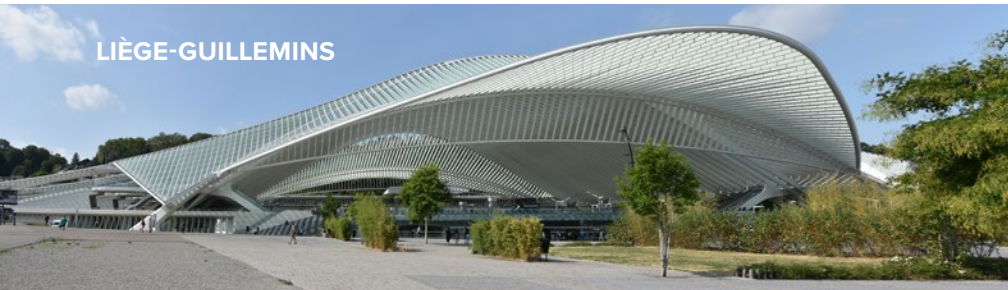
NEWER STATIONS OF WESTERN EUROPE

A person interested in taking a European trip can obtain the assistance of several travel companies. Interrail, for example, sells passes for unlimited rail travel in 33 European countries for as long as 3 months. Now that most of Europe's principal cities are linked by high-speed trains, it's possible to go long distances on morning trains, leaving afternoons free for exploration.

One of the most impressive new stations is the Hauptbahnhof, the central station in Berlin. Completed in 2006, it has a vast edifice built mainly of glass. Because Berlin was a divided city during the Cold War, its railway modernization had to wait until after German reunification in 1990. Its glassiness conveys the idea of transparency, an important theme in post-Nazi and postcommunist Germany. The station is highly functional, bringing together underground and overground local trains, in addition to long-distance and commuter lines, with connections to trams and buses outside. Inside, it doubles as a shopping mall.

Equally impressive is the long-distance railway station at Frankfurt Airport, which is a major railway interchange as well as one of Europe's busiest airports. It opened in 1999 and shows the same daring use of glass to create luminous open spaces. Above the platforms is a shallow-arched dome where passengers buy tickets and wait for their trains in comfort. A walkway from the dome carries them over an autobahn to the aircraft terminal, while adjacent escalators bring them to an array of hotels, restaurants, and shops and a conference center, all added in the years since the station opened.

Liège-Guillemins, in Belgium, is perhaps the best of all the new stations, with a high flaring glass dome designed by the controversial Spanish architect Santiago Calatrava. Its immense glass arch curves not across the platforms but along them in a prolonged shallow curve.


LIÈGE-GUILLEMINS

FRANCE'S CITÉ DU TRAIN

Turning now to railway history, the big French railway museum is Cité du Train in Mulhouse, Alsace, and its designers have done everything possible to heighten visitors' emotional state. Upon entering the first big hall, it's very noisy and almost pitch dark; as one's eyes adjust, one sees an immense express steam locomotive looming out of the blackness. Polished to a high shine, it gleams in spotlights directed from above. A dummy driver leans from one window of the cab as if ready to set it into motion. Beside it stands a ceremonial train from the era of the emperor Napoleon III. Decorated with national flags, its locomotive is white with a polished brass boiler, and it pulls an ornate VIP passenger car.

CITÉ DU TRAIN

Deeper inside the hall, a full-size steam locomotive lies on its side, enabling viewers to see parts that usually remain hidden. This exhibit is part of a recreation of the work done by the French Resistance during World War II.

The mood is slightly calmer in the museum's second hall, though even here occasional puffs of smoke burst from the funnel of an old Golden Arrow passenger express engine, adding an appropriate smell to the place. A stationary streamlined engine's wheels turn to demonstrate how the intricate connecting rods turn the back-and-forth motion of the piston into the rotary motion of the wheels.

A line of stately locomotives from the earliest days of French railroading bears witness to the development of the technology. One of the earliest includes a maker's plate showing it to have originated in Robert Stephenson's factory in Newcastle-upon-Tyne. Here, one can watch the rapid improvement of designs between the pioneering 1830s and around 1870, when the essential look of steam locomotives had been achieved.

Visitors can also see Charles de Gaulle's personal carriage from the years of his presidency in the 1950s and 1960s, along with his distinctive Citroën car and a cardboard cutout of him in uniform. Two electric locomotives with distinctive inward-slanting windshields recall the Trans Europe Express. These trains and the beautiful red *Capitole* locomotive were the predecessors of today's TGV, AVE, and Intercity Express trains. Prominent among the exhibits are a series of locomotives that broke the world's railway speed record, including the first one to travel faster than 500 kmph, a record set in 1990.

By the mid-1950s, it had become clear that the long-term future of high-speed trains lay with electrical rather than diesel trains because they don't need to carry their own fuel and are correspondingly lighter.

BELGIUM'S TRAIN WORLD

Belgium's national railway museum, Train World, is in the Brussels suburb of Schaerbeek and is adjacent to a busy working railway. Train World is housed in purpose-built structures, but the entrance is a striking Victorian-era station in polychromatic brick, served by a tram line from the city center.

The displays include talking holograms, using French, Flemish, and English, and a lavish addition of sound effects. One exhibit, a level crossing guard's house that's been reconstructed inside the building, gives an impression of how early 20th-century railway workers lived. Beside the house, a level crossing is made vivid with rushing sound effects, emphasizing the danger that passing trains presented and the importance of absolute punctuality for the guards.

At the end of the main hall, visitors climb to an upper level from which they can look down on the central floors while also visiting a second set of exhibits, including freight wagons, working models, and, best of all, a high-speed train driving simulator with interactive video display. Drivers of the simulation soon realize the challenges of driving a high-speed train, which include reducing speed for curves and urban sections, gaining speed to keep on schedule, sounding the horn on time for crossings, and stopping at just the right place in stations.

GERMANY'S RAILWAY MUSEUMS

The biggest railway museum in Germany is the Bochum-Dahlhausen Railway Museum in the Ruhr district, formerly a major coal-mining area near the industrial cities of Dusseldorf, Essen, and Dortmund. It opened in 1977 on the site of an old locomotive depot that was built just before World War I. It owns a superb collection of heavy steam locomotives along with many other important machines. Most of the locomotives have black cabs and boilers and red wheels, projecting a purposeful sense of power; many are still in working order.

Visitors also encounter the darker side of Europe's railway heritage—especially in Germany, where trains played a role in its aggression during two world wars and in shipping millions of Jews to the Holocaust death camps. A maker's plate on one locomotive labeled "Krupp, 1942" recalls the industrialist Alfred Krupp, who was closely associated with Adolf Hitler and would ultimately be convicted of crimes against humanity. In a second building stands Hitler's personal railway car, a luxurious dark-green vehicle built in 1937 and decorated with the Nazi eagle. Signs explain that when the war ended, General Eisenhower and his staff took it over, and it later became the vehicle in which visiting dignitaries rode.

Bochum-Dahlhausen is run mainly by railway enthusiasts and volunteers and does not go far to explain the wider historical context. By contrast, the German Museum of Technology in Berlin is a government-backed enterprise with a professional curatorial approach. Opened in 1983, it includes a large section dedicated to railway history but also superb exhibits on aviation, seafaring, photography, textile manufacture, and many other aspects of industrial history.

The museum's railway section, like Bochum-Dahlhausen, is mainly a matter-of-fact lineup of old black-and-red steam locomotives, with the addition of several diesel workhorses that covered the years between the decline of steam and the completion of network electrification. Visitors will also see an exhibit about the role of railways in the Holocaust.

VIENNA'S RAILWAY MUSEUM AND MODEL RAILWAY

Vienna, like Berlin, has a first-rate museum of technology that takes on a wide range of topics in land transport, medicine, sanitation, photography, aviation, and science. Steam locomotives dominate the ground floor and offer a reminder that Austria, as an Alpine country, needed a lot of tractive power in its mountain districts. Pride of place goes to a mighty 1930s-era steam locomotive, the *12.10*, which pulled high-speed passenger trains from Vienna to Salzburg at 100 mph. The *12.10* is all black apart from red connecting rods and has been restored to pristine condition.

A variety of earlier steam locomotives stand nearby, including *Ajax*, which was built in England and shipped to Vienna in 1841, when railways were in their infancy. The museum claims that *Ajax* is the earliest steam locomotive on display anywhere in Europe; it certainly bears witness to the way British technology helped to jump-start railways all over Europe in the 1830s and 1840s.

Next to the steam locomotives, one of which is cut open longitudinally to show its inner workings, stands a steel converter. Now just a hulking egg-shaped rusty container, the converter was once a caldron full of red-hot molten iron. It's a useful reminder of the symbiotic relationship between railways, iron and steel making, and coal mining.

The immense open spaces of the Vienna museum are just right for the numerous big objects on display, and by climbing to each of its four levels, it's possible to get a new perspective on the great set pieces down below. On the highest level stands a supplementary display on railway history, again paying tribute to British inventions with perfect scale models of Richard Trevithick's first locomotive and Robert Stephenson's *Rocket*. Informative sections on freight railways, signaling, and the development of passenger cars complete the presentation.

Nearly all the museums discussed in this lecture include model railways, but the model most worth a visit is the Königreich der Eisenbahnen, or "Kingdom of Railways," in the Vienna fairground district. What makes it stand out is the fact that it's a model of the entire city. Dozens of Vienna's stately palaces, churches, museums, and formal streets, including the Ringstrasse, have been carefully duplicated to a very high standard, with the railways and trams running among them as in real life. The copy of Vienna's main station is accurate down to the smallest detail. Visitors can walk around three sides of this huge model and enjoy the switch, every 10 minutes, from daytime to nighttime, whereupon thousands of lights transform the scene.

READING

Patterson, Michael. *The Great Railway Stations of Paris*. Gloucestershire: Amberley Publishing, 2018.

Solomon, Brian. *Brian Solomon's Railway Guide to Europe*. Waukesha, WI: Kalmbach Books, 2018.

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Repurposed Railways

Railways have been going out of service since before 1850, and especially in the years since 1950—in Britain because the Beeching plan condemned them as uneconomical, and in America because most passenger railways were no longer justifiable while freight lines were consolidating. Because they were heavily engineered in the first place, however, former railways are attractive for many other uses, and many of them have been turned into footpaths and bicycle trails, giving rise to the rails-to-trails movement. This lecture explores some of the creative approaches that have been used to give new life to old railway lines, stations, and trains around the world.

SUBURBAN RAIL-TO-TRAIL CONVERSIONS

In 1986, Americans Peter Harnik and David Burwell created the Rails to Trails Conservancy. By then, American lines were being abandoned at a rate of 2,000 miles per year, and they recognized a wonderful opportunity to transform them into trails. They argued that trails built along old railroads would appeal to a population that was becoming more health conscious and more environmentally sensitive and that these trails would enrich the neighborhoods through which they ran. The fact that they often boosted local property values tended to make them attractive to local politicians, too.

The Silver Comet Trail near Atlanta, Georgia, runs 61 miles from the city's western suburbs to the Alabama state line along the path of the former Seaboard Air Line Railroad. The trail is named after an express train that used to run on the line between 1947 and 1969. At the Alabama state line, it continues as the Chief Ladiga Trail and runs another 33 miles into Anniston, making a combined length of 94 miles. It's crowded with walkers, cyclists, and runners on spring and fall weekends. Bike rental and repair shops and cafés have sprung up, too, often in converted railroad buildings.

In the suburbs of Washington DC, the Washington and Old Dominion Trail incorporates a wide variety of scenic settings as it heads west, passing through the towns of Reston and Herndon and eventually ending in Purcellville, Virginia. Here, too, are bike rental shops, restaurants, and cafés along the route.

TRAIN STATION IN PURCELLVILLE, VIRGINIA

The most ambitious of all these projects is the Great American Rail-Trail, which aims to link up old lines across the entire nation, making a continuous trail of about 3,700 miles that will stretch from Washington DC to Washington State, passing within 50 miles of 50 million Americans' homes. It still has a long way to go, but powerful organizations support it and have attracted influential political support, so its prospects are excellent.

Britain, like the United States, is crisscrossed by former railways that now serve as bicycle paths and footpaths. Two converted lines in the county of Derbyshire, the High Peak Trail and the Tissington Trail, meet at a junction called Parsley Hay, on an exposed upland meadow near the old spa town of Buxton. The High Peak Trail goes southeast from there, winding through hilly country past old limestone quarries, mostly inside the Peak District National Park, and comes eventually to the old station at Middleton Top, now a café and bike rental center. A mile farther along, the trail reaches a steep inclined plane that was built in the 1830s, up which railway wagons were once pulled by a long cable. At the bottom is the village of Cromford, one of the earliest factory sites of England's Industrial Revolution.

Britain has developed a nationwide network of abandoned railways, canal towpaths, and minor roads where cyclists can avoid heavy traffic, collectively known as Sustrans, short for *sustainable transportation*. As with its American counterparts and comparable schemes across much of Europe, it continues to grow and prosper.

URBAN RAIL-TO-TRAIL CONVERSIONS

Manhattan's High Line is a 1.5-mile-long linear park on what was once an elevated railway. The last train ran in 1980, and the line decayed, becoming a weed-littered slum. But renovation by an alliance of landscape architects and ecological activists led to the first section opening in 2009, with more to follow. Starting below 14th Street on the west side of Manhattan, it heads north to just beyond 34th street. All along the way are gardens, art exhibits, and short sections of the old railway track now planted with attractive vegetation. The only limitation, which some people might see as a virtue, is that there's no room for bikes.

Comparable to the High Line but less developed is the elevated 2.5-mile-long Bloomingdale Trail in Chicago. It opened in 2015 and was designed to be the centerpiece of a complex of trails linking many parts of the Chicago metro area.

The inspiration for these American trails came from the Promenade Plantée in Paris, a 3-mile section of disused railway track. Begun in the 1990s, it blends walking trails, gardens, and even a section of shallow pools. Starting near the Place de la Bastille, it heads east, crossing a succession of avenues before descending on a curving bridge to ground level after about a mile. It eventually descends below street level to incorporate a series of tunnels and cuttings that are decorated with artworks and a maze of hedges. It ends where the line encounters another disused railway that circles the inner suburbs of Paris—La Petite Ceinture, disused since 1985 but still supporting rusted tracks. It, too, is being revived as a walking trail.

Between 1916 and 1981, the American railway system had shrunk from 254,000 to 186,000 miles.

REPURPOSED TRAIN STATIONS

As passenger travel sank to insignificance in the United States, some stations lost their rationale. That was the fate of the Cincinnati Union Terminal, which was built between 1927 and 1933 to serve seven railroads and is one of the greatest art deco buildings in the nation. Luckily, its many admirers rescued it from the wrecking ball after it closed to passenger service in 1972. After a false start as a shopping mall, it reopened in 1990 as a center for four museums and an IMAX theater.

Union Station in St. Louis is another revived terminal. Originally built in the 1890s, Union Station was the world's biggest railway station in its day. And it grew even bigger, extended first to accommodate the influx of visitors to the world's fair of 1904 and then again to deal with increased travel during World War II. The great central hall is now a hotel lounge. It also includes an aquarium, a giant Ferris wheel, a hall of mirrors, a zipline and rope course, and a museum of rail travel.

Britain, too, needed fewer stations after the Beeching plan, but it preserved and converted the best of them. Manchester Central, for example, was taken out of service in 1969. A place of architectural importance in its own right, it featured a beautiful arched interior of iron and glass that was second only in size to that at London St. Pancras. Still in beautiful condition, Manchester Central is enjoying a second life as a conference center and a concert venue.

One of the most audacious and successful transformations was that of a Paris railway station, the Gare d'Orsay, into one of the city's leading art galleries. Originally completed in 1900 on a superb site beside the Seine river and just across from the Louvre, the Gare d'Orsay was the terminal for trains from southwestern France. By World War II, however, the length of its platforms was inadequate. The Gare d'Orsay was turned first into a commuter station but then abandoned, and for a while it faced demolition. In the 1980s, however, the station was transformed into a national art gallery, the Musée d'Orsay, designed to contain works that were more recent than those housed in the Louvre but not as contemporary as those housed in the ultramodern Centre Pompidou. Meticulously made over to bring out the beauty of its structure and decoration, it reopened in 1986 and now houses a formidable collection of paintings by Courbet, Van Gogh, Monet, Gauguin, Degas, Renoir, and others.

The old Norfolk and Western Railway station in Roanoke, Virginia, has been turned into the O. Winston Link Museum, honoring the photographer whose astonishing nighttime photographs of the line's steam locomotives from the 1950s made his name synonymous with railroad photography.

A secondary station in Seville, Spain, the Plaza de Armas, was converted into a movie multiplex and shopping center in the 1990s. Its exterior arches echo those of the nearby Alcázar Palace, parts of which date back to the Moorish era. The arched train shed follows the classic design of stations all over Europe, a span of glass and cast iron. The beautiful plate glass screen at what used to be the open end, where trains came and went, is an impressive counterpart to the decorative stained glass windows at the enclosed end and the additional stained glass in the side windows.

CONVERTED RAILROAD CARS

Railroad cars converted into bed-and-breakfasts or Airbnb accommodations are common on both sides of the Atlantic. One of many ingenious conversions is the Red Caboose Motel in Strasburg, Pennsylvania, where every guest room is an old railroad caboose. They are still painted in the liveries of the companies from which they came and make a colorful lineup in three rows. Strasburg is the perfect place for them because it's the site of a working steam railroad and the home of the Railroad Museum of Pennsylvania and the National Toy Train Museum.

Another project is a hotel and conference center at the old Chattanooga Terminal Station in Tennessee. Trains no longer run into and out of the station, but its central building is an impressive block with an interior domed ceiling. Railroad cars standing alongside the platforms have been converted into hotel rooms, and an adjacent landscaped space holds music and art festivals.

The irony of this place is that it probably owed its survival, after the last train departed in 1970, to a song the Glenn Miller Orchestra recorded in 1941 for the movie *Sun Valley Serenade*. That song, "Chattanooga Choo Choo," begins with a brilliant imitation by the orchestra of a steam train starting off slowly, then gaining speed and blowing its steam whistle—it's one of the most effective imitations of a train ever transfigured into music. It then evokes the idea of a homesick soldier heading back from New York to Tennessee to be reunited with his old girlfriend.

Railways were a brilliant contribution to the Industrial Revolution and have had huge positive consequences all over the world. Seemingly condemned to a terminal decline by the late 20th century, their efficiency, greenness, and speed have helped them to recover so that they remain a vital and fascinating part of our world—a place that they seem likely to maintain into the indefinite future.

READING

Cotton, Nick. *Traffic-Free Cycle Trails: The Essential Guide to over 400 Cycling Trails around Great Britain*. Sheffield: Vertebrate Publishing, 2020.

David, Joshua, and Robert Hammond. *High Line: The Inside Story of New York City's Park in the Sky*. New York: Farrar, Straus, and Giroux, 2011.

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