Rails to Oblivion: The Decline of Confederate Railroads in the Civil War

by
Dr. Christopher R. Gabel

COMBAT STUDIES INSTITUTE

FOREWORD

Military professionals need always to recognize the centrality of logistics to military operations. In this booklet, Dr. Christopher R. Gabel provides a companion piece to his "Railroad Generalship" which explores the same issues from the other side of the tracks, so to speak. "Rails to Oblivion" shows that neither brilliant generals nor valiant soldiers can, in the long run, overcome the effects of a neglected and deteriorating logistics system. Moreover, the cumulative effect of mundane factors such as metal fatigue, mechanical friction, and accidents in the civilian workplace can contribute significantly to the outcome of a war. And no matter how good some thing or idea may look on paper, or how we delude ourselves, we and our soldiers must live with, and die in, reality. War is a complex business. This booklet explores some of the facets of war that often escape the notice of military officers, and as COL Jerry Morelock intimated in his foreword to "Railroad Generalship," these facets decide who wins and who loses.

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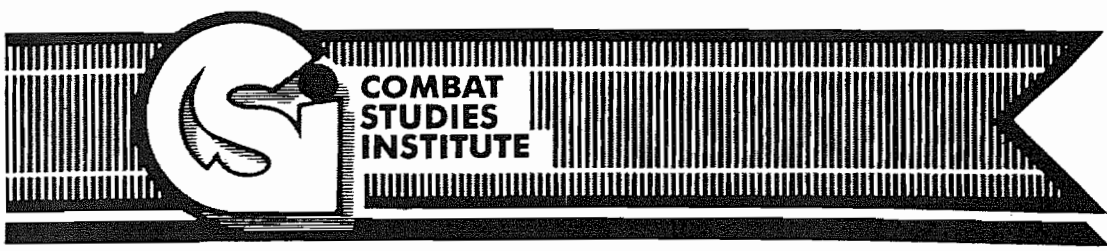

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Rails to Oblivion: The Decline of Confederate Railroads in the Civil War

Christopher R. Gabel, Ph.D.

A feature commonly found in general history books on the American Civil War is a set of statistics comparing the resources of North and South at the time of secession. Although such statistics may vary from source to source, they invariably show that the North enjoyed major advantages in terms of population, industrial capacity, wealth, and railroads. A careless reader might infer from these statistics that the Confederate States of America was doomed and the outcome of the Civil War decided before the first shot was fired. Even the more prudent reader might assume that these resource disparities were causal factors in the Confederacy's defeat. However, such assumptions overlook the fact that the war lasted four bloody years, and ultimately approximated the modern notion of "total" war. If the Confederacy's resource disadvantages were truly as debilitating as the statistics suggest, the war should have ended much earlier than it did.

Railroads are usually included in such comparisons of relative resources. Statistics show that the Confederacy possessed only one-third of the miles of track found in the United States at the time of secession, one-third of the freight cars, one-fifth of the locomotives, one-fifth of the railroad workers, one-eighth of rail production, one-tenth of the telegraph stations, and one-twenty-fourth of total American locomotive production. Did this disparity constitute a crippling disadvantage for the South? On the contrary—Southern railroads were in fact sufficient for the Confederacy to win the war, or perhaps it would be more accurate to say that the Southern rail system was good enough to win *a* war. This distinction will become clearer as we proceed.

In fact, the rail net in the southern United States prior to secession was a huge system and was expanding rapidly. During the decade of the 1850's, it quadrupled in extent, growing by 7,000 miles. Although the seceded Southern states had only thirty-three percent of the prewar US rail mileage, they also had only forty percent of the population total, thus the per capita level of rail service was not dramatically different from that in the North (see Chart 1). Moreover, when compared to other nations, the new Confederacy possessed the third largest national rail

• New England and Mid Atlantic:	10,000
• Middle West:	11,000
• South:	9,000
	30,000

Chart 1
Miles of railroad track in the United States, 1860.

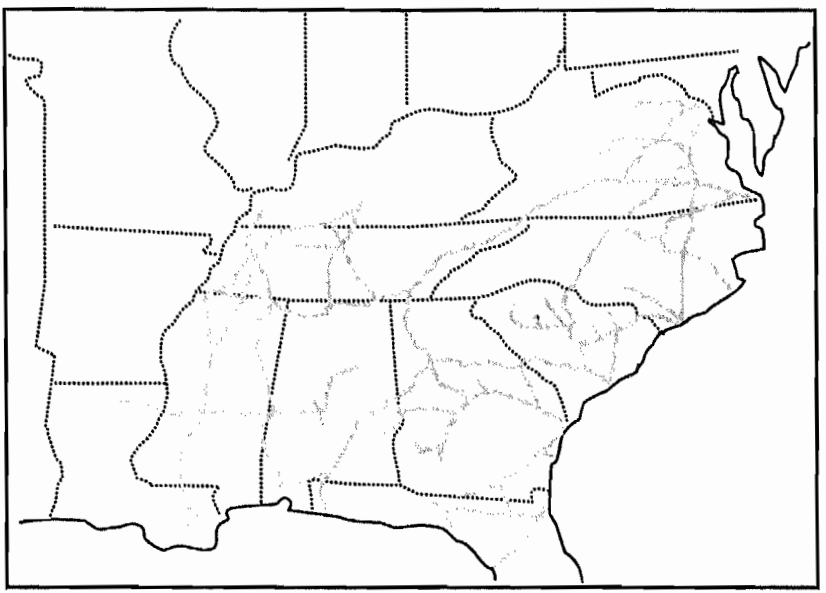
system in the world, ranking behind only the northern United States and Great Britain in rail mileage (see Chart 2).

Moreover, southerners as a whole were enthusiastic supporters of railroads and rail expansion. They invested money in railroads both privately and through state and municipal governments. The states of Virginia and North Carolina owned large blocks of stock in their states' railroads. Georgia owned a major railroad outright. Other Southern states loaned money for railroad construction within their borders. The railroad was an important part of public and private life throughout much of the South.

Thus the Confederate States of America was, at the time of its inception, endowed with a major asset in the form of its railroads. It is also true, however, that the Southern railroads labored under some serious deficiencies that prevented their full utilization for military purposes. The most significant of these problems was that the Confederate rail system was really a collection of relatively small railroads, and was not in fact a "system" at all. Southern railroads were typically short feeder lines connecting agricultural areas to water ports

• US (North)	21,000
• Britain	10,000
• **US (South)**	**9,000**
• Germany	7,000
• France	6,000

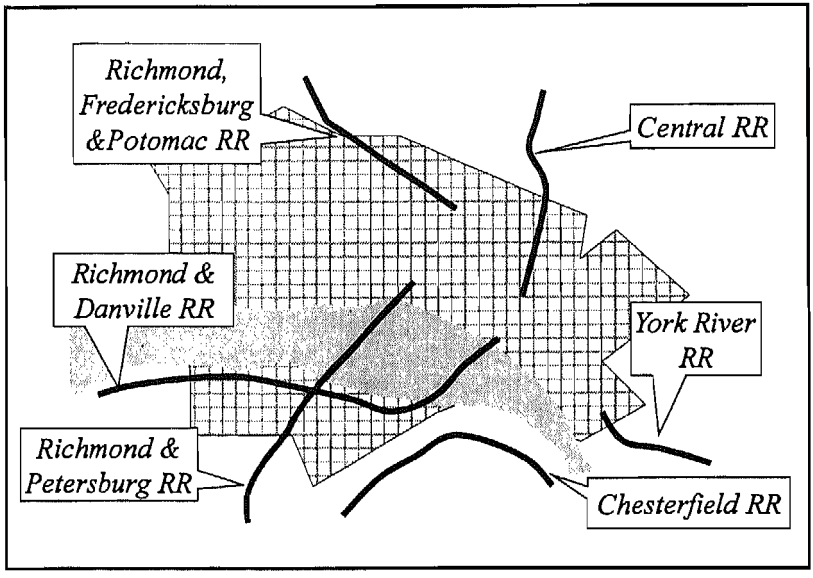
Chart 2
Comparison of railroad track mileage, 1860.



Map 1
Principal Confederate railroads, 1861.

(see Map 1). For example, the South Carolina Railroad, which ran the first scheduled steam-powered trains in America in 1830, was constructed to draw agricultural products from the hinterland to the city of Charleston for the benefit of the city's merchants. Such railroads were not, as a rule, city-to-city or inter-regional transportation corridors. When war came, these railroads were not well suited to the long-distance hauls that military strategy required. One could argue that the South's navigable waterways, and not the railroads that fed them, were really the Confederacy's national transportation system.

As a result, there was often no physical connection between railroads. In 1861, no fewer than six different railroads served the city of Richmond, Virginia, yet none of these lines connected with another (see Map 2). Even in cases where physical connections did exist, there were usually no arrangements between railroads for the locomotives or cars from one to use the tracks of the other. To travel long distances, passengers and freight usually had to change cars every time they passed from one railroad to the next. Railroad stockholders—typically, local businessmen, municipalities, and state governments—viewed railroads as a way to bring people and goods into town. They did not see

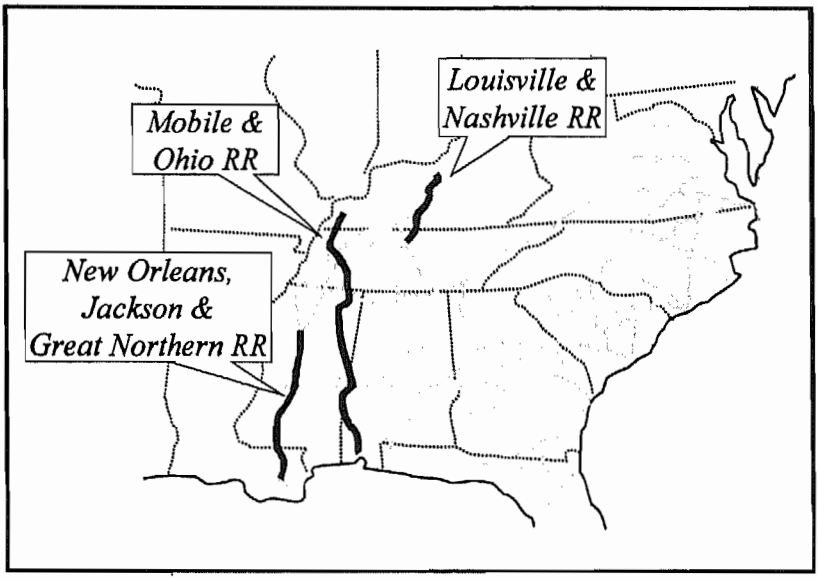


Map 2
Richmond, Virginia: six railroads, no interchange.

transportation as a business in and of itself and had no interest in seeing traffic come in one end of their railroad and go out the other.

In the 1850's some longer, regional (as opposed to local) railroads appeared in the south, most notably certain north-south lines west of the Appalachian Mountains (see Map 3). Unfortunately for the Confederate war effort, these lines were in the wrong place (and ran in the wrong direction) for the support of most military operations. What the Confederacy needed were east-west lines linking the major theaters of war. The most direct rail line for this purpose, running from Memphis, Tennessee to Virginia, was in fact four separate railroads (see Map 4 on page 6). The longest of these segments bore the imposing title "Memphis and Charleston Railroad," but in reality its tracks ran only from Memphis to Stevenson, Alabama.

The problems of railroad interconnection and long-haul traffic were not unique to the South. Northern railroads typically also had originated as local feeder lines for ports. Cities served by multiple rail lines, such as Philadelphia, lacked connections between railroads. As in the South, traffic moving from the eastern seaboard to the Mississippi Valley had to travel over four or more rail lines. However, in the North, the process of consolidating short railroads into larger interregional trunk lines was

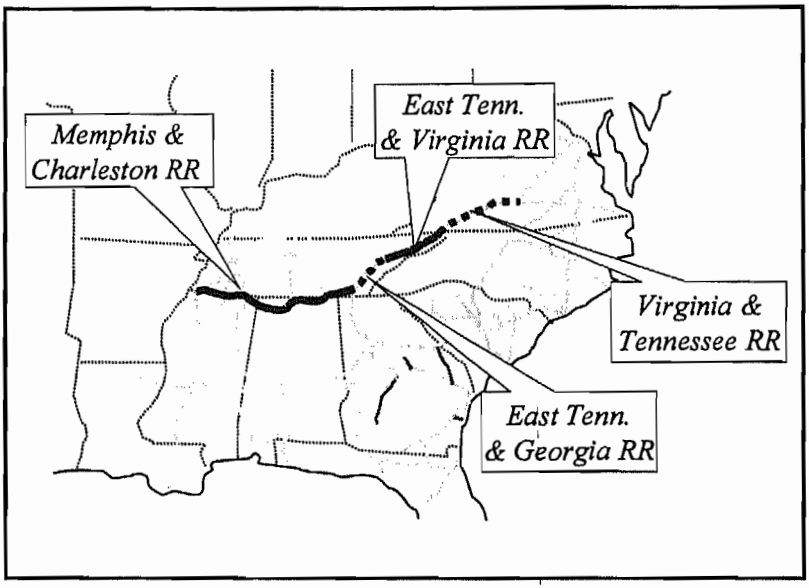


Map 3
Major rail construction in the South, 1850's.

farther advanced than it was in the South, where local stockholders still dominated the railroad business. By 1861, no fewer than four major east-west railroads traversed the Appalachian Mountains in the North.

The problem of interchanging traffic between Southern railroads was not primarily one of different track gauges, as many Civil War books suggest. Such histories often assert that Northern railroads were "standard gauge," meaning that the distance between rails was 4 feet, 8 ½ inches on all lines, whereas Southern railroads utilized a multiplicity of gauges, preventing the interchange of locomotives and cars. In fact, there was no "standard" gauge anywhere at the time of the Civil War. The so-called "standard" gauge was most common in the Northeast. Ohio and Indiana railroads were generally of 4 foot, 10-inch gauge. Missouri railroads used a gauge of 5 feet, 6 inches. The Erie Railroad in New York State ran a gauge of 6 feet. A total of eleven different gauges could be found on Northern railroads.

Southern railroads may actually have been more standardized than those on the North. The most widespread gauge in the South was 5 feet, which was common in Tennessee, Mississippi, Louisiana, Alabama, Florida, Georgia, South Carolina, and some lines in Virginia. Other railroads in Virginia, and those in North Carolina, utilized 4 feet, 8 ½ inches.



Map 4
Main Confederate east-west rail artery.

From an engineering point of view, there was no inherent advantage to the 4 foot, 8 ½ inch railroad gauge. Nor did differences in gauge absolutely preclude the interchange of cars. Railroad cars with special five-inch-wide wheels could negotiate both "standard" gauge and "Ohio" gauge tracks, though not very safely. Where differences in gauge were greater, third rails could be laid between existing rails to accommodate cars of narrower gauge. Some cars were constructed with wheels that could be moved in and out on the axles, making it possible to change the gauge of the wheel-sets themselves. It was also feasible to lift cars off their wheels with hoists, then lower them onto wheel-sets of different gauge. In the final extremity, track could be re-laid to a different gauge with much less difficulty than one might expect. In 1871, the Baltimore and Ohio railroad purchased an existing rail line that ran 340 miles from Cincinnati to east St. Louis. The newly purchased line used 6-foot gauge track, whereas the Baltimore and Ohio was a 4-foot, 8 ½- inch-gauge line. Work crews converted the new line to standard gauge in only eight hours. And in 1886, those southern railroads still running on 5-foot gauge all shifted to standard gauge in the space of two days, relaying 13,000 miles of track in the process.

Thus, the railroads of the Confederacy entered the Civil War with significant problems in interchanging traffic and with long-distance hauls, though differences in gauge was by no means the only problem. Getting the railroads to work together as a system was not an unattainable goal, but it would have required centralized coordination and perhaps even compulsion. The only agency capable of exercising such control was the Confederate government. The government of the United States, which faced comparable problems, established in 1862 the US Military Railroads, an agency within the War Department that had compulsory powers over the Northern railroads. Not until May 1863 did the Confederate Congress grant comparable powers to its executive branch. The US Military Railroads ultimately became the largest railroad in North America, complete with administrative, construction, and operational capabilities. In contrast, the Confederate military railroad agency never became more than a small contracting, advisory, and coordinating bureau within the Confederate War Department.

The most fundamental difference between the US and Confederate military railroad agencies was that the individuals who ran the US Military Railroads possessed both the expertise and the authority to do the job. Daniel C. McCallum, director of the USMRR was a railroad man of long experience and a pioneer in the field of railroad organization. He also frequently enjoyed direct access to the Secretary of War. Commissioned as a colonel, he eventually attained the rank of brigadier general. McCallum knew what had to be done and, with the Secretary of War backing him up, had the power to make it happen.

By way of contrast, consider the case of William S. Ashe, the first head of the railroad office within the Confederate War Department, serving in that capacity from July 1861 to April 1862. Ashe had once served as president of the Wilmington and Weldon Railroad, but he was really a politician and a businessman rather than a hands-on railroad man. His political credentials were probably more important than his expertise as qualifications for the position. Given the official title of Assistant Quartermaster General, he lacked direct access to the Secretary of War. Ashe was commissioned as a major, a rank too low to carry much influence in either civilian or military circles. Lacking both a staff and any compulsory powers over the railroads, Ashe could not solve the problem of coordinating the Confederacy's railroads. Upon his departure, Ashe's position went unfilled for seven months.

His successor, William M. Wadley, was one of the most experienced railroad men in the Confederacy. Born in New Hampshire but a

long-time resident of the South, Wadley worked for railroads in Georgia, Louisiana, and Mississippi before the war. He certainly brought expertise to the job, but he exercised little more authority than his predecessor, despite the fact that he was appointed with the rank of colonel. For reasons unknown, the railroad office under Wadley was transferred from the Quartermaster to the Adjutant General's department. Like Ashe, Wadley sought to obtain cooperative agreements among the Confederacy's railroads, but lacked the authority to do more than advise and recommend. When the Confederate Congress passed legislation in 1863 granting compulsory powers to the government, it also specifically denied Wadley's commission to the rank of colonel. Effectively stripped of authority, Wadley departed government service in June of that year.

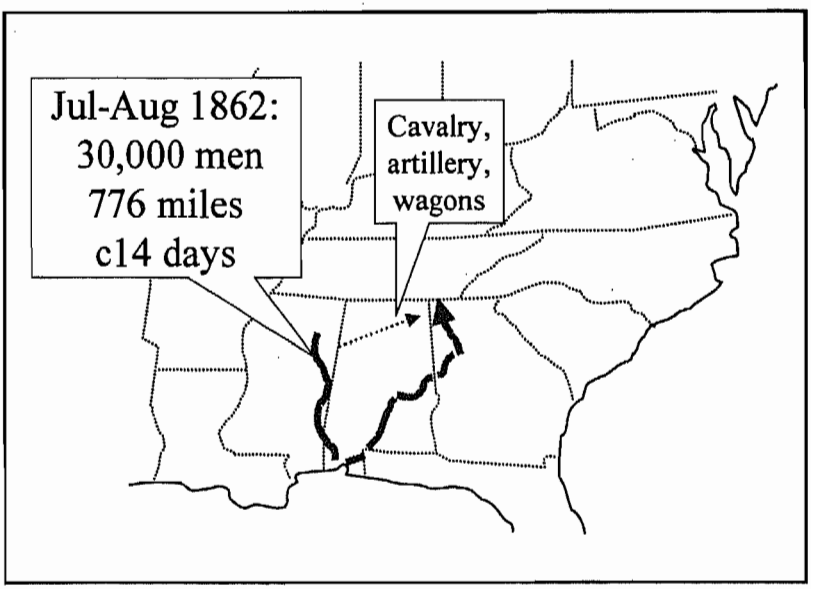
Next came Frederick W. Sims, who headed the railroad bureau from June1863 to the end of the war. Sims had some experience in the business side of railroading, and he had served under Wadley for a while, but he was better known for his activities in publishing and philanthropy than in railroading. Appointed to the rank of lieutenant colonel, Sims was able to move his agency back under the Quartermaster General where it belonged. Although the government never delegated to him the compulsory powers authorized by the Confederate Congress, Sims brought to the job a flair for wheeling and dealing that enabled him to accomplish more than either of his predecessors. Thus, although neither his expertise nor his authority was particularly extensive, Sims was able to coordinate vital military traffic when necessary.

A perennial problem that confronted Sims as well as his predecessors was the question of rates charged by the railroads for military traffic. At the outset of the war, the Southern railroads promised free transportation to the Confederate army. This commitment fell through quickly for the simple reason that no business can afford for long to give away its product free of charge. Thereafter, Ashe, Wadley, and Sims attempted to negotiate the lowest possible rates for government traffic. Although they generally succeeded in securing rates that were lower than the charges for civilian traffic, this apparent victory for the military actually turned out to be a defeat. Because the railroads could make more money hauling civilian cargo than military, to the end of the war the railroads preferred civilian traffic to military business. In other words, the Confederate military paid bargain rates and got cut-rate service in return.

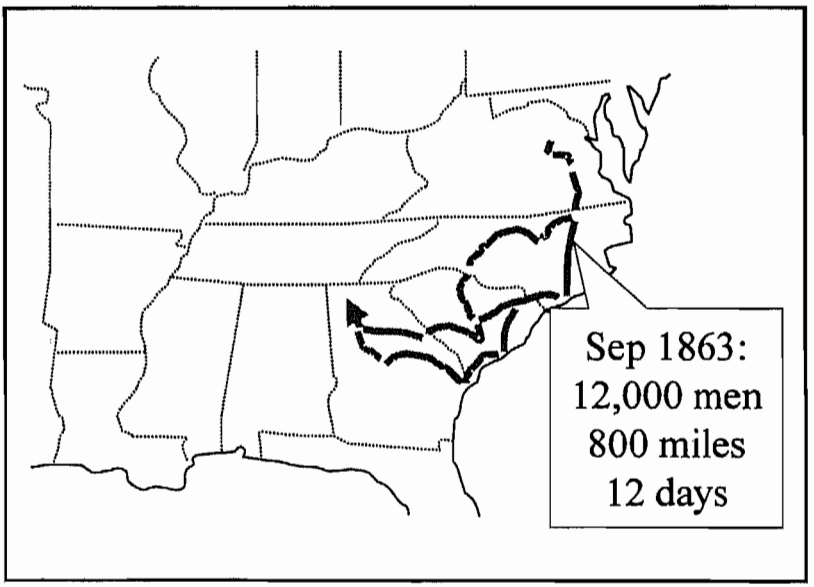
In contrast to the Confederate experience, the United States government paid somewhat higher s and got better service. Moreover, when military necessity demanded, the US Military Railroads could and would move in and take over any railroad needed for the support of vital military operations. The threat of military takeover, coupled with the money to be made hauling military traffic, persuaded the Northern railroads to become willing supporters of the war effort.

It is true that the Northern railroads backed the Union war effort more efficiently that the Southern railroads supported the Confederate effort. However, it can also be argued that the Confederacy did not require the same high degree of support from its railroads. The Confederates, being on the strategic defensive, faced a far simpler problem in logistics than did the Union military, which had to mount offensive operations on a continental scale. With specific regard to the railroads, it should be noted that the vast majority of the US Military Railroads' efforts were expended on captured railroads, not Northern lines. The military seizure of Northern railroads was rare. In general, the Union government negotiated with Northern railroads in much the same manner that the Confederate government dealt with the Southern lines, with the important difference that the Northern railroads knew that they faced compulsion if they failed to cooperate.

Indeed, the evidence suggests that the Confederate railroads performed adequately through the first two years of the war. Despite the various inefficiencies inherent to poor coordination and less-than-effective centralized control, no Confederate army lost a battle in that period because of a failure of rail support. On the contrary, the period 1861-63 may well be seen as a period of Confederate military railroading triumphs. In the first large-scale battle of the war, the First Battle of Bull Run in July 1861, Confederate troops arriving by rail were the decisive factor in securing a Confederate victory. A year later, Southern railroads conducted the single biggest military rail movement of the war, when the army commanded by General Braxton Bragg moved from Tupelo, Mississippi to Chattanooga, Tennessee (see Map 5). Over a period of about two weeks, 30,000 soldiers moved 776 miles to launch Bragg's invasion of Kentucky. In September 1863, Lieutenant General James Longstreet's corps of 12,000 men traveled 800 miles from Virginia to northern Georgia and the Battle of Chickamauga (see Map 6). This movement required Sims to coordinate traffic on fourteen different railroads. Had the war ended in



Map 5
Bragg's rail movement from Tupelo to Chattanooga.



Map 6
Longstreet's rail movement from Virginia to Chickamauga.

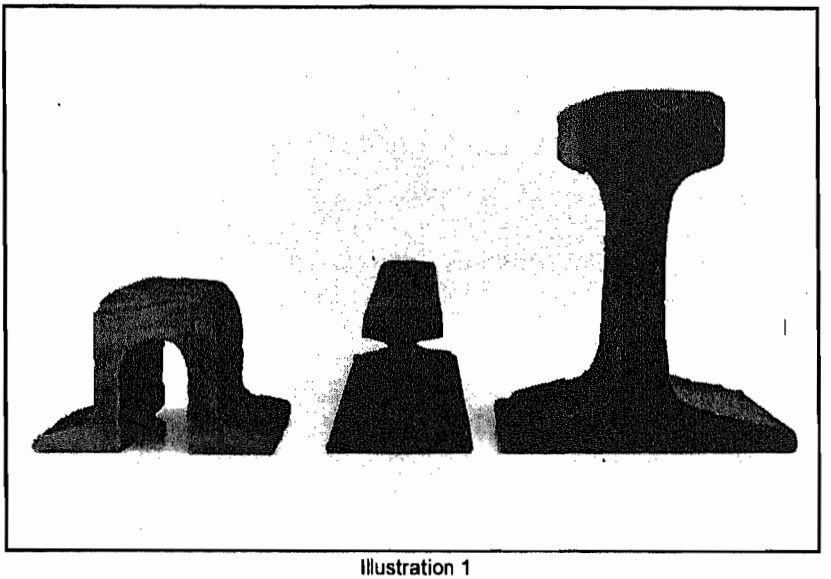


Illustration 1
A comparison of obsolete and modern rail. Left to right: Civil War-era U-rail; 30-pound rail such as might have been found on Civil War railroads; and modern rail of 132 pounds. The 132-pound rail stands about 7 ¼ inches high.

1863, historians might well list the Confederate railroads as a decisive element contributing to Confederate victory.

Yet the Confederate rail system ultimately did fail, and historians point to that failure as a contributing cause of Confederate defeat. What went wrong? The fatal flaw was, in fact, time itself. The war simply lasted too long for the Confederate railroads to sustain it. How can time cause a rail system to fail?

First of all, there is wear and tear to the physical plant, starting with the rail itself. The rail used in the 1860's was much smaller than that employed today (see Illustration 1). Rail size is measured by how much a yard of rail weighs. Modern railroads use 120-pound rail or larger. (Three feet of rail weighs 120 pounds.) In the 1860's, heavily-traveled main line railroads employed 60-pound rail. Moreover, it was made of iron, not steel, so even though Civil War-era locomotives and cars were proportionately lighter than those today, the rail still wore out as fast or faster. (A Civil War era locomotive weighed about thirty tons, compared to 134 tons or more for a modern diesel. Freight cars in the 1860's carried about ten tons of cargo apiece, as opposed to 100 tons today.) Rail could wear out in as little as three years on the most heavily-traveled lines.

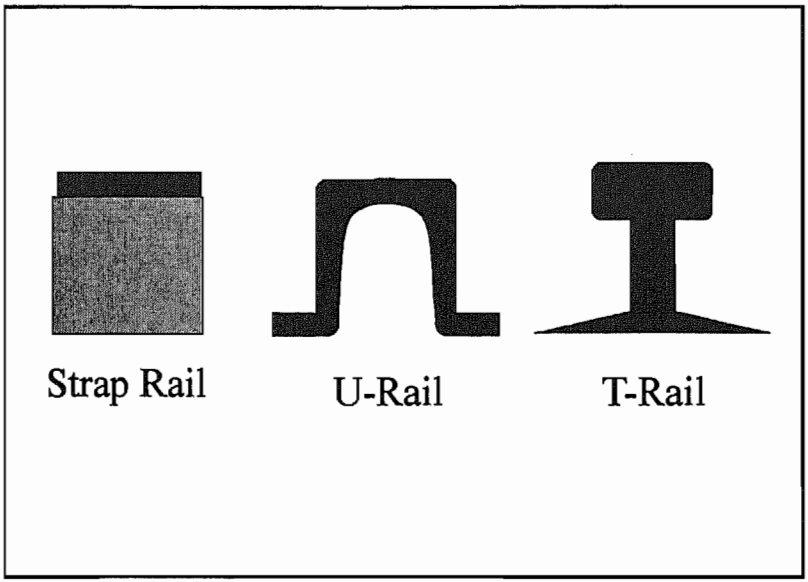
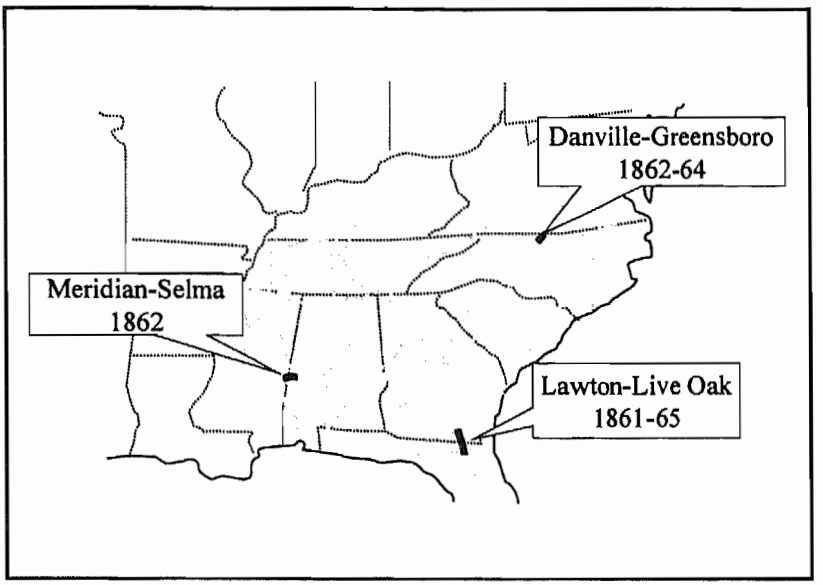


Figure 1
Types of rail used on Confederate railroads.

The Confederate War Department estimated that the Southern railroads would need 49,500 tons of new rail each year just to replace worn-out track. This equates to 467 miles of track laid with 60-pound rail. In 1860, Southern mills produced only 26,000 tons of rail, just over half the amount needed merely to maintain existing rail lines. Before the war, the South imported most of its rail from England and from the North, which produced 222,000 tons per year. With the onset of war, Northern rail was, of course, no longer available. Imports from England also dropped off, because rail, being a high-bulk, low-value cargo, was not suited to blockade-running. Moreover, domestic production of rail dropped essentially to zero, because the industrial plants that manufactured rail shifted to other production.

The rail situation was exacerbated by the fact that not all Southern railroads ran on good rail when the war began. Although the modern form of rail, known as "T-rail," was already in widespread use, many Southern lines still used obsolete "U-rail." Others even employed antiquated "strap rail," also known as "flatbar," which consisted of wooden rails topped by a strip of light iron (16 to 22 pounds per yard) (see Figure 1). The Richmond and Danville Railroad, which became one of the more important Southern rail arteries during the war, included forty-seven miles of strap rail in 1861.



Map 7
Wartime railroad construction in the Confederacy.

By 1863, rail was wearing out all over the south, and stockpiles of new rail were nearly gone. The deterioration of rail triggered second and third order effects that rippled throughout the Confederate rail system, involving even those railroads that still ran on good rail. Worn-out rails forced trains to run slower, which meant that more trains were needed to maintain delivery rates. Thus worn rail contributed to a system-wide shortage of locomotives and cars, and reduced the amount of cargo delivered.

Given the normal wear and tear on rails, plus the desirability of replacing strap-rail and U-rail, the Confederacy had no rail left to expand its railroads. The North added approximately 4,000 miles of tracks during the war, which was actually much lower than the rate of new construction in the pre-war years. The Confederacy, on the other hand, could only attempt to close small gaps between existing railroads (see Map 7). The rail used in these projects was generally obtained by cannibalizing other railroads, often against the will of the donors. Eventually, the Confederate government would also confiscate rail from low traffic railroads to replace worn-out rail on vital lines. As the war progressed, the major rail lines stayed open, but low-traffic feeder lines actually contracted. This may have contributed to the general shortage of food in Confederate cities and army camps in the last

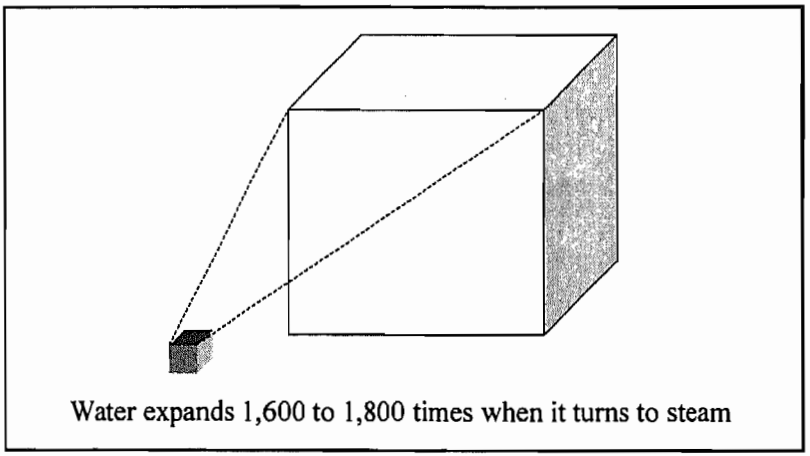


Figure 2
The expansive power of steam.

months of the war. More food was being grown in the South than ever, because many farms that once grew cotton had shifted production to food crops. However, the crops raised could not always be shipped due to the cannibalization of rural rail lines.

Railroad rolling stock suffered from wear and tear as well, most notably, the locomotives upon which all rail transportation depended. To fully comprehend the dimensions of this problem, it is important to understand how steam locomotives work. The concept of steam power is based upon the fact that water expands 1,600 to 1,800 times in volume when it is turned into steam (see Figure 2). It is this expansive force that powers steam locomotives.

The key components of a steam locomotive are its firebox, boiler, and pistons (see Illustration 2 and Figure 3). Fuel (in the 1860's, usually wood) is burned in the firebox, heating the water in the boiler. Hot combustion gases pass through pipes inside the boiler and exit the locomotive through the smokestack. Water in the pressurized boiler turns to steam and is replenished by water pumped from a small car called a "tender," which is attached to the rear of the locomotive. Steam collects in a dome at the top of the boiler and is carried under pressure through pipes to the cylinders at the front of the locomotive. There a set of valves injects the steam alternately in front of and behind the pistons, driving them back and forth. The back-and-forth motion is transmitted to the drive wheels by a series of rods. Rods connect to the wheels on "eccentrics" (off-center hubs) that convert the back-and-forth motion

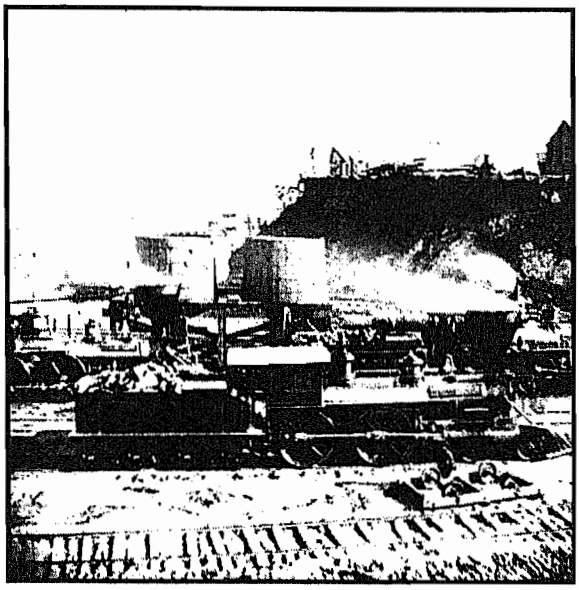


Illustration 2
A typical Civil War locomotive.

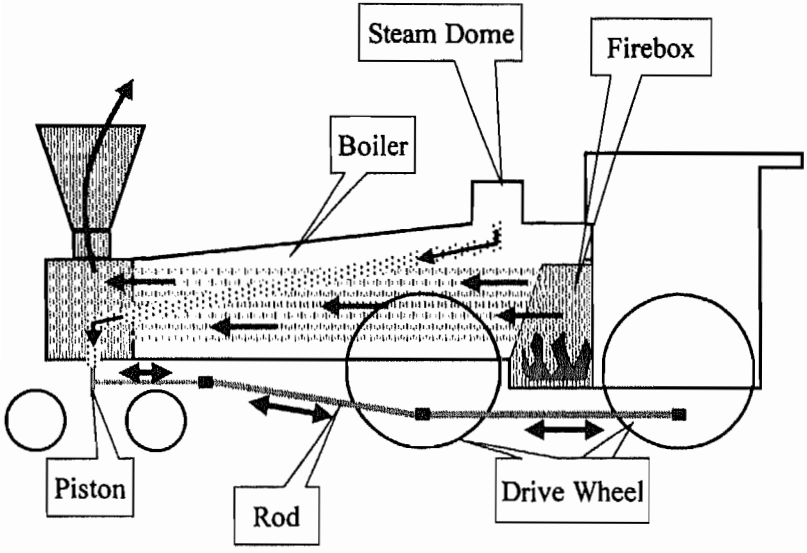


Figure 3
Major components of a steam locomotive.

of the rods into round-and-round motion that propels the locomotive over the tracks.

Thus, the operation of a steam locomotive involves water, heat, pressure, and the friction of numerous large moving parts. All of these are the enemies of iron. It is no exaggeration to say that a steam locomotive incrementally destroys itself every time it is fired up. Steam locomotives require rebuilding at regular intervals, a process that includes complete disassembly and replacement of major components such as the firebox and flues (the pipes that carry hot gases through the boiler). Rebuilds were necessary every few years for locomotives in regular use. Between rebuilds, items such as the tires (bands of specially-hardened metal fitted over the drive wheels) would wear out and need replacement. Flues needed regular cleaning. Bolts on frames and trucks needed re-tightening and valve-gear for the pistons would require regular adjustment. Routine maintenance during normal operation included lubricating the drive linkages, cleaning the firebox, and "blowing down" the boiler every hour or so. If the family minivan required the level of maintenance of a steam locomotive, one would have to stop every hour for fuel and oil, change tires every few months, and get a complete engine and transmission rebuild every two years.

Unfortunately for the Confederacy, the Southern railroads were short of virtually everything needed for locomotive maintenance, including lubrication oil, machine tools, steam gauges, copper, tin, steel (for tires), and even files. Substitutes for some materials existed—one railroad found it possible to use bacon grease in place of the whale-oil lubricants that became unavailable after secession. Others could not be replaced at all. As locomotives deteriorated, so did performance. Speeds dropped, making it necessary for locomotives to make more runs in order to maintain delivery rates, thus compounding the maintenance problem.

Nor were new locomotives available. Locomotive manufacture was really an extension of the locomotive maintenance issue, because many establishments that were capable of rebuilding locomotives could also build new ones. Before the war, new locomotive construction took place in Richmond and Petersburg in Virginia; Atlanta, Georgia; and Nashville, Tennessee. Tredegar Iron Works in Richmond was the largest producer of locomotives in the South, completing perhaps as many as ten per year in the 1850's. In 1860, Southern establishments built a total of nineteen locomotives. This compares poorly to the 451 locomotives built that year in the North, including eighty-three constructed at the North's largest facility, the Baldwin Locomotive

Works located in Philadelphia. Both before and during the war, the great majority of Southern locomotives were of Northern manufacture. Once the war started, Southern locomotive production dropped to zero. Tredegar focused on armaments production, as did many other facilities that otherwise might have built locomotives. Except for a handful of locomotives captured during the war, Confederate railroads had to meet the heavy demands of wartime transportation with the locomotives on hand when the war began. And, of course, these locomotives deteriorated as the war progressed.

By 1863, the locomotive maintenance problem had become acute. In that year, the annual report for the Virginia and Tennessee Railroad listed forty locomotives on the roster. Of that number, nine were classified as "useless," and another nine as "awaiting repair." It appears that all of this attrition was due to normal wear and tear, not to enemy action. Since locomotives were non-standardized hand-built items, it would have been difficult or impossible for the Virginia and Tennessee to salvage parts from one locomotive to keep others running.

Railroad cars deteriorated over time, too. Cars in that era were constructed almost entirely of wood, and were expected to last seven or eight years under normal use. However, repairing a car involved withdrawing it from service, which the wartime demands for transportation made more difficult. While the Confederate railroads could and did replace wooden components, and even build new cars, the production of cast-iron wheels and wrought-iron axles posed greater problems. A railroad wheel is a deceptively sophisticated device. The virtue of rail transport derives from the fact that the contact patch, or surface of the wheel in actual contact with the rail, is very small, thus minimizing friction (see Figures 4 and 5). Railroad wheels are tapered, a feature which reduces stress on curves where the wheels on either end of the axle move at different speeds. Even a minor imperfection in a wheel can force a train to slow down, damage rail, or cause a derailment. Worn-out wheels, along with bad rail and deteriorating locomotives, lowered train speeds and reduced the volume of traffic.

The Confederacy did possess the capability to manufacture new wheels, but ironically, as the rail system deteriorated, production of wheels went down. Foundries in Augusta, Georgia which were capable of producing fifty wheels a day were making only fifteen a day by 1863, because the railroads could not deliver materials in sufficient quantity to maintain full production. Naturally, as wheel production declined, so did deliveries of raw materials, further depressing production. Moreover, a

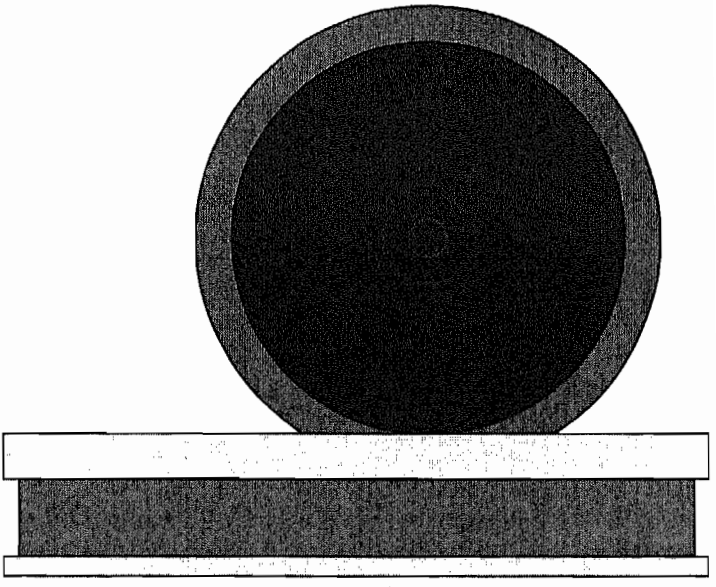


Figure 4
Railroad wheel on rail (1).

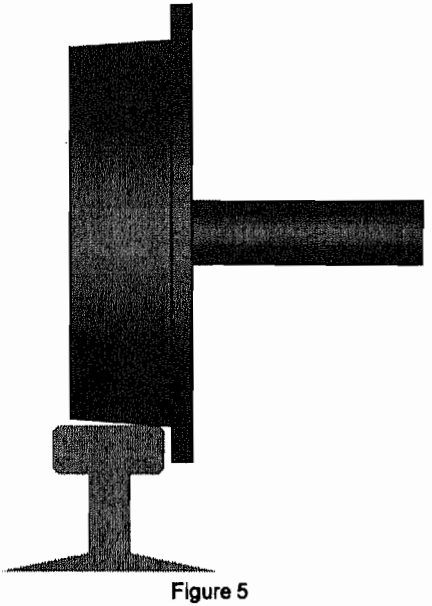


Figure 5
Railroad wheel on rail (2).

railroad wheel that cost $15 in 1861 cost $500 by the end of the war, owing to ruinous rates of inflation that crippled not only the railroads, but also all aspects of the Confederate economy.

Railroad personnel constituted another asset that declined as the war progressed. Railroading in the 1860's was a manpower-intensive business. A typical train, carrying 100 tons of cargo, required a crew of five to seven men. (In contrast, a freight train today needs a crew of two to move 10,000 tons of cargo.) The crew included an engineer to operate the locomotive, a fireman whose full-time job consisted of fueling the firebox and monitoring water levels and steam pressures, and a conductor who supervised the overall operation of the train. The remainder of the crew consisted of brakemen, who clambered from car to car to set manual brakes when the train was required to slow or stop. In addition to train crews, railroads employed track crews to maintain the right-of-way. Heavily-traveled lines employed as many as four to five men per mile of track just for maintenance. Additional personnel included station agents, telegraph operators, switch-men to operate the manual switches that diverted rolling stock from one track to another, craftsmen and laborers to maintain rolling stock, and accountants to keep the books.

The Confederacy started the war with about 16,000 railroad employees. This figure began immediately to decline. Some railroad workers from Northern states went home at the time of secession. An unknown number of others volunteered for military service. Still others were drafted. The Confederate conscription law of 1862 initially exempted railroad workers, but not all draft officials honored the exemption. Moreover, the law was amended in October 1862, narrowing the railroad exemption to management and skilled workers. Another amendment in 1864 further narrowed the exemption. Competing demands for labor, such as the armaments industry, depleted the ranks of skilled railroad workers even more.

Much of the unskilled labor on Southern railroads was traditionally performed by slaves, both those owned by the railroad itself and others hired out by plantation owners. As the war progressed, this source of labor declined as well. Slaves working on the railroad were more likely to escape or be liberated by Union raiders than those engaged in agricultural work, thus making owners reluctant to place their slaves in such labor.

Attrition among railroad workers was bad enough under normal circumstances without the added problems caused by the war. Railroading was a dangerous business in the 1800's. Rough estimates

suggest that two to four percent of railroad workers were injured or killed on the job *each year* during this period. One-third to one-half of these accidents arose from the couplers used to link railroad cars together. The modern "knuckle" coupler, used universally in the United States today, had not been invented at the time of the Civil War. Knuckle couplers engage automatically when cars are pushed together. In the 1860's, cars were coupled with the link-and-pin system. This technology required a worker to stand between cars (one of which was moving), guide a link by hand into the pocket of the oncoming car, and then drop a pin down through the pocket (see Figure 6). Needless to say, accidents were frequent. (Parenthetically, it was a Confederate veteran named Eli H. Janney who invented the knuckle coupler still used today.)

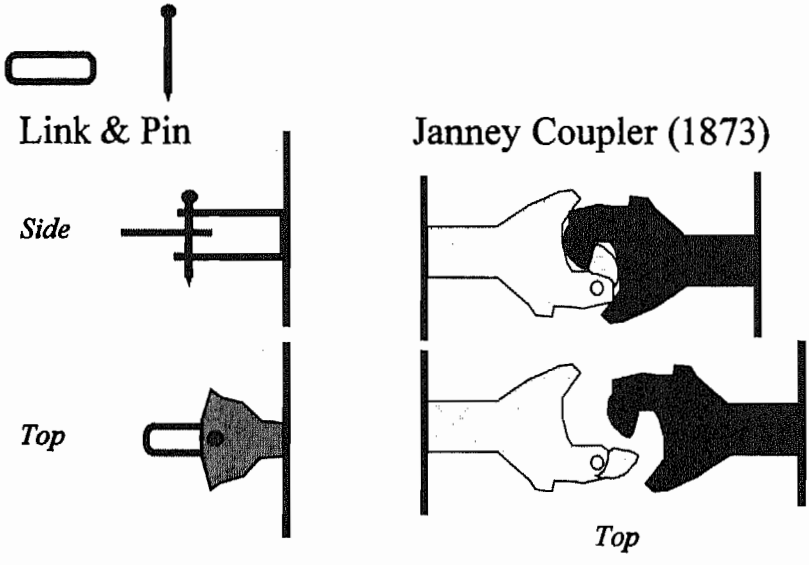


Figure 6
Railroad coupling systems.

A much rarer, but more dramatic way of becoming a railroad casualty was through boiler explosions. Water in the boiler of a locomotive is hotter than 212 degrees Fahrenheit. Most of it remains in liquid form because it is kept under pressure. Civil War-era locomotives operated on a boiler pressure of about 140 pounds per square inch. (In the 20th Century, boiler pressures exceeded 200 psi.) If the pressure within a boiler is suddenly released, all of the water in the

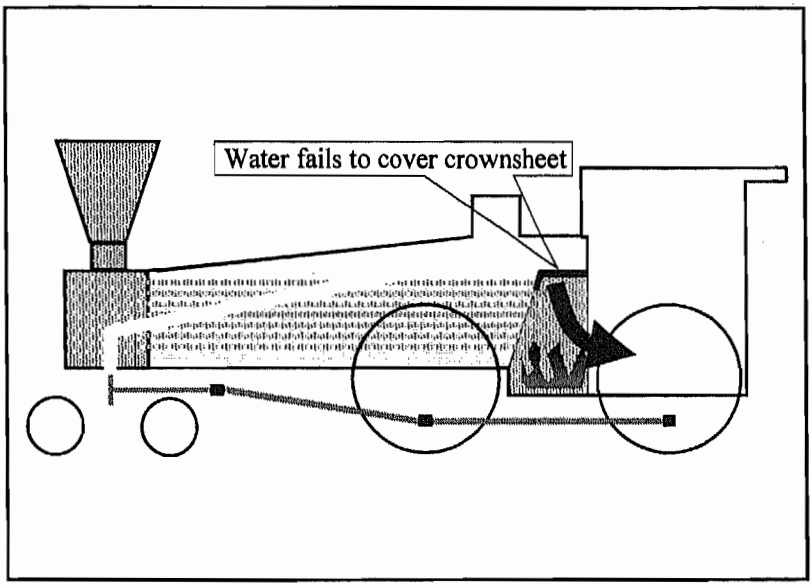


Figure 7
Most common cause of boiler explosions.

boiler tries to turn into steam at the same time, expanding 1,600 times in volume, and creating an explosion like a bomb. One boiler explosion in the 20th century threw a 150-ton locomotive 131 feet through the air, killed the engineer immediately, and tossed the fireman (who later died) 206 feet. The force of the explosion was estimated at three million pounds per square inch.

The most common cause of catastrophic boiler explosion (then and now) is low water level in the boiler (see Figure 7). Through crew negligence, obstructed water supply, or faulty gauges, water in the boiler drops so low that it no longer covers the "crownsheet," as the top surface of the firebox is called. Lacking water on the boiler side to carry away heat, the crownsheet gets hotter and hotter until it weakens and breaks, releasing the pressure inside the boiler. Even if the rupture is not large enough to cause an explosion, the escape of steam into the cab is sure to injure or kill the crew.

Obviously, railroad workers who are poorly trained or exhausted from overwork are more likely to suffer from operating accidents than experienced, well-rested crews. It is reasonable to assume that the Confederacy's shortage of railroad workers led to increased accident rates, further exacerbating the labor shortage.

However, the most critical personnel shortage was not among operating crews; rather, it was the inadequate supply of "mechanics," or machinists, for locomotive maintenance. Locomotives in the Civil War era were not mass-produced items. Replacing a part often meant fabricating a new one. Mechanics capable of such work were skilled craftsmen who underwent extensive apprenticeships before mastering their trade. The Confederacy had only a small pool of such skilled workers when the war began, and had no time to develop apprentices into master machinists or metalworkers. Moreover, the railroads had to compete with the armaments industry for these critical personnel. The shortage of mechanics on the Confederate railroads set up yet another vicious cycle—maintenance deferred because of the lack of skilled labor invariably resulted in even more serious problems later.

By the last year of the war, Confederate armies were beginning to go hungry because the railroads could no longer maintain adequate levels of supply. Ironically, thousands of the hungry soldiers sitting in army camps were the very railroad workers whose absence impeded the performance of the railroads. Perhaps these individuals could have been put to better use delivering supplies rather than consuming them.

The final factor contributing to the demise of Confederate railroads was the Union raider, who tore up track, burned bridges, and destroyed rolling stock. However, by 1864, when Union raids became truly effective, the decline of the South's railroads was already well-advanced. Raids only accelerated the on-going process of attrition.

It is more difficult to do lasting damage to a railroad deliberately than one might assume. Consider the problem confronting a Union raider who rides up to a Confederate rail line on horseback, carrying nothing but a carbine and perhaps a few hand tools. What can he do to damage an infrastructure that was built to withstand the pounding of a thirty-ton locomotive? Any damage that he inflicts can probably be repaired with little more effort than the raider expended in causing it. Union cavalry raiders operating around Atlanta in 1864 discovered that rail lines that took a day to "destroy" would be back in operation two or three days later.

Railroad bridges, commonly constructed of wood, were vulnerable to fire, but it took time for a raiding party to gather combustibles and get a blaze going to the point that it could not easily be extinguished (see Illustration 3). Herman Haupt of the US Military Railroads developed an explosive "torpedo" that could wreck a bridge much more expeditiously. This device consisted of a tin can filled with black powder, with a bolt running through it from end to end. The head of the

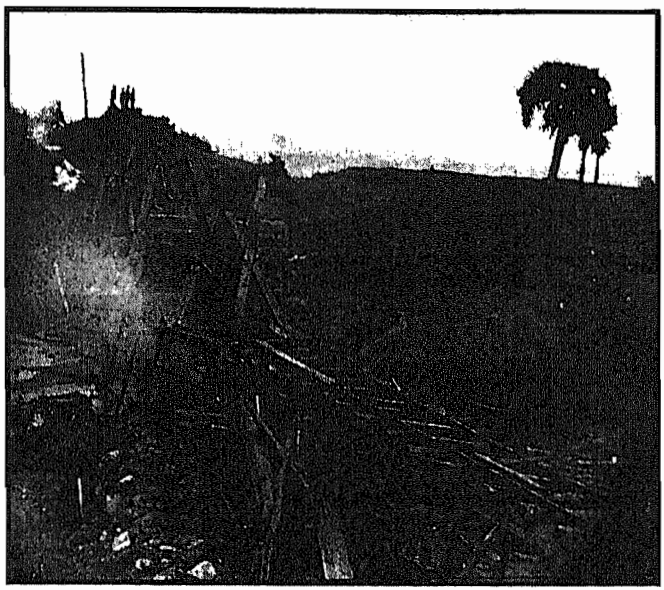


Illustration 3
Destroyed railroad bridge on the Richmond, Fredericksburg, and Potomac Railroad.

bolt sealed one end, and a nut sealed the other, leaving space for a fuse to protrude from the can (see Illustration 4). Using a simple hand auger, a raider could bore a hole in a bridge timber, insert the torpedo, and detonate it. If he picked the right timber to destroy, one raider could drop a bridge in a few minutes. However, it is not clear that this device ever saw widespread use.

Union raiders expended much effort in attacking track. Rail would be torn up (with considerable effort), and placed on top of a pile of burning ties. When the rail was red hot, the raiders would then bend it, or even wrap it around a tree. This, too, was time-consuming and labor-intensive, particularly for lightly-equipped cavalry raiders. Moreover, rail subjected to this treatment could usually be straightened and re-laid, sometimes right on the spot.

The US Military Railroads came up with a better way to ruin rail. One of Haupt's subordinates, E. C. Smeed, invented a portable device that made it possible to both tear up rail quickly and to twist it, which generally ruined the rail for good. The Smeed device resembled a large horseshoe which raiders could carry easily on horseback. The insertion of a handy telegraph pole or fence-rail into the device turned it into a giant crow-bar. Using only muscle-power and leverage, raiders could

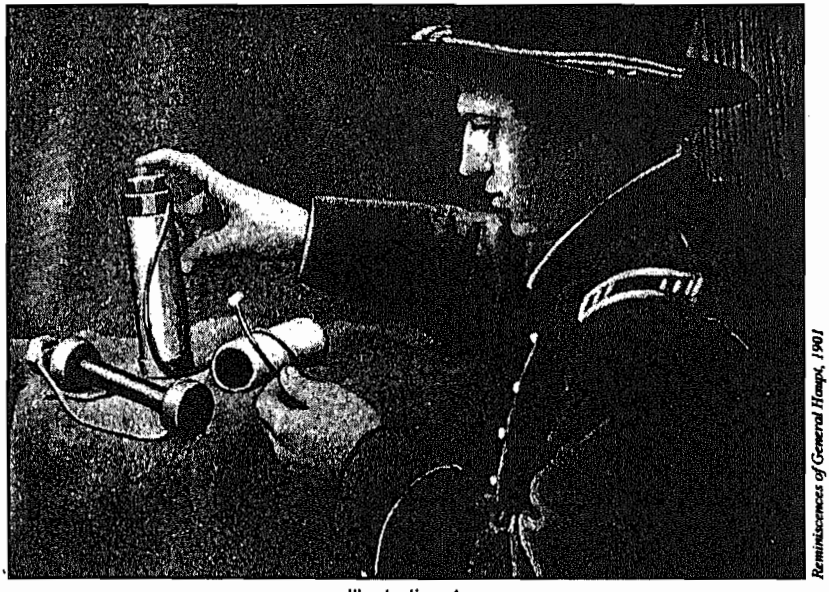


Illustration 4
Haupt's "torpedo."

lift and twist rail quickly (see Illustration 5). Once again, however, it is not known to what extent this device actually was used.

From early 1864 to the end of the war, the Confederate ability to restore railroads damaged by Union raids began to decline. Major General William T. Sherman's large-scale expedition through Mississippi in February 1864 caused damage that took four months to repair. When Sherman cut a swath of destruction across Georgia later that year, some of the affected rail lines remained out of service for the duration of the war. The permanence of the disruption wrought on such raids was due partly to the increased magnitude of the destruction, and partly to the Confederacy's declining ability to muster the labor and materials needed to rebuild.

The Confederate government, as a matter of principle, offered little or no aid to railroads damaged through acts of war. Often explained as an example of the "states rights" philosophy of limited government, this inaction is inconsistent with the government's willingness to conscript railroad workers and confiscate rails. The Confederacy was willing to take, but not give.

By late 1864, the railroads of the Confederacy were slipping from decline into collapse. In December, a division under the command of

Illustration 5
Smeed rail twister.

Major General Robert F. Hoke set out on a movement by rail from Petersburg, Virginia to Wilmington, North Carolina. Its itinerary took it over the Piedmont Railroad, one of the few stretches of new track built during the war. Hoke's lead brigade required three days to travel forty-eight miles over the Piedmont, owing to the miserable condition of rail and rolling stock. The remainder of the division walked the forty-eight miles.

In February 1865, the Confederate government proposed re-gauging some tracks across North Carolina from 4 feet 8 ½ inches to 5 feet, so that broad-gauge locomotives and rolling stock could be evacuated from South Carolina. Governor Zebulon Vance of North Carolina successfully defied the government, and the South Carolina rolling stock was lost.

Finally, in March of 1865, Brigadier General Isaac M. St. John, the newly-appointed Commissary General, reported that he could not guarantee the delivery of 500 tons of military rations per day into Richmond, on top of other military and civilian traffic. Once again, the decrepit condition of locomotives and railroad cars was to blame. Food aplenty was piling up in the depots of rural Virginia, but the railroads

had lost the ability to move what amounted to five trains per day into the nation's capital.

General St. John's report serves as a fitting epitaph to the Confederate railroad system. It began the war as a powerful military instrument, capable of shaping campaigns and winning battles. Through 1863, the railroads performed capably and helped sustain the Confederacy in a war that might otherwise have ended in quick defeat. It is no coincidence that in the years during which the railroads performed well, the Confederacy was able to hold its own militarily. The decline and ultimate collapse of the railroads paralleled the downfall of the Confederacy itself. The South's inability to sustain its railroads over time, and not the railroads themselves, proved to be a fatal flaw. The railroads died of neglect, and the Confederate States of America found itself on the rails to oblivion.

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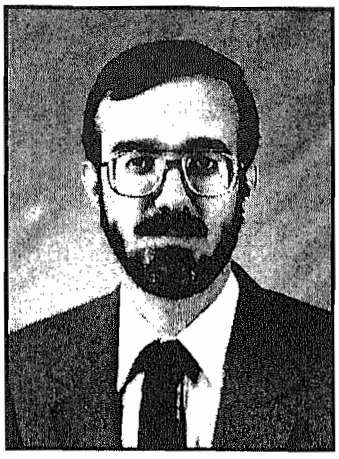

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