opening of the Reading Railroad in the 1840s. This line had been a special creation of its fiscal manager, Biddle, backed by his Bank of the United States. Coal cars simply loaded up near the mines, went in trains down to the port, and rolled directly onto sea-going ships. Anthracite production jumped to 3.5 million tons by 1847.

Widespread American industrial use of coal, all of it the nationalists' Pennsylvania anthracite, began in the 1830s.

Biddle intervenes

Meanwhile, Biddle steered the national economy on an upward curve. The Bank of the United States invested in railroads and purposefully bid up the price of their securities. State governments run by Clay-Adams Whigs built canals, and issued bonds which were marketed by Biddle's Bank; midwestern states were populated and filled with towns and industry as an immediate consequence.

When Wall Street or London drove the prices of some commodity too high or too low, Biddle intervened directly into the market to counteract the speculators, and restore steady growth and prosperity for farmers. The Bank of the United States and other financial weapons at Biddle's disposal, were used in exactly the same way that Hamilton had fought against the international bankers who claimed the right to dictate to the world.

President Andrew Jackson vetoed a renewed charter for the Bank in 1836. American credit became pinched, and then the Bank of England pulled the plug on the United States, stopping all credit lines and sending into bankruptcy the British firms that dealt with America. Depression gripped the U.S. economy in 1837, with hunger, unemployment, and fear.

But Biddle continued the Bank for a time under a Pennsylvania state charter. Near bankruptcy, he and his allies kept pushing for modernization,

With the final push of the 1842 protective tariff law, every major American industry changed immediately to machine production, to factories in the general sense we have known them since. During the effective years of this last Clay tariff, 1843-47, metal machines came to replace wooden ones. Newly applied industrial steam power gave one American worker the power of hundreds of people in countries not thus equipped.

There was a general rush to invest in manufacturing, to cash in on the protective tariff and the new technological circumstances. Boston financiers shifted funds into industrial plants and railroads, as they had begun to do under the Carey-Clay tariff of 1828.

But America's great start toward modernization was being dragged down by the power of the slave owners and other free-market advocates, who had closed the national bank and again blocked the protective tariff. A new flank in science and technology would prepare the nation for victory in the great crisis to come.

4. International scene becomes electrified

The American nationalists worked closely with their European friends to overcome the British Empire's forceful opposition to industrialization. Britain's very active factional allies (or paid spokesmen) within each country reiterated Adam Smith's notion of the "division of labor between nations"—some were destined to supply raw materials, some could "naturally" manufacture.

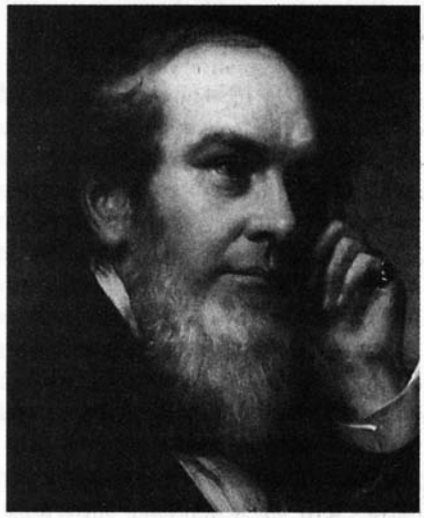
In 1839, Czar Nicholas I sent Russian engineers to the United States, who met with engineers, inventors, and railroad officials throughout the country. The leader of this mission, Pavel Melnikov, reported back to the czar that Russia, with its great spaces to connect, must emulate America's railroad construction.

Several years later, Melnikov and Crown Prince Alexander II headed a committee to begin this development. The Russians hired a retired U.S. Army officer, George Washington Whistler, one of the original West Point engineers who had been assigned by President John Quincy Adams to design the first American railroad, as project supervisor. Whistler directed construction of the line from Moscow to St. Petersburg, Russia's first significant railroad. Whistler also built rail factories and fortifications, while engines were imported from the Baldwin Locomotive company of Philadelphia. In this period, Russia implemented a protective tariff, under which it began to create an iron industry and a factory system.

But the U.S. ability to sustain such development was in serious question. The charter of the Bank of the United States had expired on March 3, 1836. For the next 25 years, there would be only brief episodes of sane Presidential policy direction, until Abraham Lincoln rescued the country from impotence and bankruptcy.

Cognizant of the crisis they faced, the Philadelphia nationalists prepared a new enterprise to increase long-term national strength. A committee chaired by Nicholas Biddle came to be in charge of a substantial sum of money, the legacy of banker Stephen Girard, to found Girard College. On July 19, 1836, Biddle's panel commissioned Alexander Dallas Bache to tour Europe and study the finest educational methods. A confidential part of the young man's mission was to meet and coordinate efforts with the scientific elite of continental Europe.

Bache was to become one of the most important figures of civilization in the nineteenth century: The great-grandson of Benjamin Franklin, Alexander Dallas Bache had graduated with highest honors from the U.S. Military Academy at West Point in 1825—the year that West Pointers launched American railroads. Bache's cheerful diligence, and the general



Germany's Leibnizian mathematician Carl F. Gauss (left) shaped modern science for America and the world, despite violent British repression. Gauss coordinated with Alexander Dallas Bache (right), Benjamin Franklin's great-grandson, who led American science and education, and created military institutions, including the Naval Academy. Friedrich List (center) sought to unify small German states into a single nation. Imprisoned and exiled, List helped lead the U.S. nationalist revival, then returned to Europe representing America. His railroad and tariff program led to modern Germany.

awareness of his distinguished family tree (he was also the grandson of Treasury Secretary Alexander Dallas, who had rechartered the Bank of the United States) gave him great confidence, and inspired others to cooperative endeavors. Bache spent a year teaching at West Point and two years building fortifications in Rhode Island.

In 1828, Nicholas Biddle, then the chairman of faculty nominations at the University of Pennsylvania, invited Lieutenant Bache to return to Philadelphia to be a professor of natural philosophy and chemistry. Bache became the research leader of the new Franklin Institute, through which Bache gained close working ties with manufacturers, inventors, and skilled craftsmen. Bache headed the institute's federally funded inquiry into the causes and remedy of steam boiler explosions, leading to the design of more powerful American engines.

Bache and a close associate, physicist Joseph Henry, embarked together for Europe on Feb. 20, 1837. The two statesmen-scientists would take different paths, on complementary assignments. Bache's journey would encounter wild political fireworks, and would help lay the basis for an unprecedented improvement in mankind's condition.

By the end of 1837, a strategic confrontation was to occur between the British royal family and their opponents, including Bache. The British would move violently to suppress the work of the world's leading scientific thinkers, whose achievements would make the emerging power of America and Europe unstoppable.

List begins the German nation

To understand the explosive events, we must first review the work of certain scientists and political strategists, working cooperatively in the United States and Germany.

Prof. Friedrich List returned to Europe in 1830. List had sought appointment as a U.S. consul, as a promoter of U.S. exports. He proposed to get the French and German authorities to build railroads from the North Sea to southern Germany—railroads which could use and also distribute imported American anthracite coal. He was chosen as U.S. consul in Hamburg, but the British party there protested the appointment of this "dangerous political fugitive," and the U.S. Senate rejected his nomination. He served in other appointments as an official U.S. representative, including as consul in Leipzig in 1834-37.

List's influence in his native Germany had grown immensely during his years in America. As Europeans saw the success of America's nationalist economic measures, Prussia had taken halting steps toward unification with the some of the other German states ruled by princes.

At first he resided in Paris, the European headquarters for America's republican intervention into Europe's politics. List worked in Paris with Lafayette and the German poet Heinrich Heine, and through continual correspondence, with Henry Clay and the Philadelphians, and with the von Cotta family in Germany.

As his nationalist freedom movement grew, its opponents were forced to retreat. The people of the German state of Hanover demanded a constitution from their ruler, who was none other than William IV, the king of England, and son of the infamous, insane George III. (Recall that Hanoverian George I jointly ruled England and Hanover; he became England's king when his mother—Leibniz's ally—Electress Sophie, died before she could accede to the throne.) In 1833, King William IV granted a constitution with orderly laws and certain basic freedoms to quiet the demands from the people of Hanover.

On Jan. 1, 1834, List's program of German unification was largely realized, when Prussia joined with other German states in the *Zollverein,* or Customs Union; 18 states were soon united, within an external tariff barrier protecting them from British import dumping. The *Zollverein,* implicitly the birth of the German nation, jolted the British into action. Foreign Minister Lord Palmerston coordinated British policy with Austria's Prince Metternich, who had openly denounced the industrial development taking place in the uniting German states. King William countered the *Zollverein* with a British-Hanover-centered group of German states.

In 1834, List, now U.S. consul in Leipzig, proposed a Leipzig-Dresden railroad to begin a German national railway grid. Under the sponsorship of the king of Saxony, a railway company was formed and the line was completed by 1837. Throughout this period List's influence grew, with backing from Alexander von Humboldt and his colleagues in the Prussian government. List's railroad magazine (the full title was: *The Railroad Journal, or National Magazine of Inventions, Discoveries & Progress in Commerce, Industry, Public Undertakings & Public Institutions, and of Statistics of National Economy and Finance*) was particularly well received.

If U.S. Consul Friedrich List had kept a log book of all his undertakings, it would have provided a unique window on the nineteenth century. For example: musician Clara Wieck lived for a time in the List household in Leipzig; composer and cultural leader Robert Schumann fancied one of List's daughters before deciding to marry Clara Wieck; and Schumann, a few years later, gave List a copy of his *Liederkreis* ("song cycle") Opus 24, set to Heinrich Heine's poems, to take to Heine in Paris.

In 1837, Metternich banned List's journal from Austria, and got the U.S. government to revoke his appointment as consul; List moved back to France. In conjunction with the American allies there, List worked up proposals for bringing France into an industrially powerful anti-British bloc with Germany.

Electrical science enters world politics

With the above backdrop, we see the stage set, politically, for the explosion which was to greet Alexander Dallas Bache, the representative of America's political, military, industrial, and scientific leaders, when he arrived in Germany at the end of 1837.

Bache was slated to meet in a kind of "grand council" with German scientists Carl F. Gauss and Wilhelm Weber at Göttingen University. Bache had been working in Philadelphia on the measurement of the earth's magnetism, in accord with Gauss's scientific work. More importantly, Gauss and Weber had been experimenting, in tandem with American and French researchers, to develop the world's first electrical machines, that could greatly strengthen the nations which were in potential conflict with Britain. These devices included the telegraph, that could shrink the great spaces of Russia and America, speed Germany's modernization, and proffer military advantages; and the electric motor, whose use to power industry would greatly outstrip Britain's industrial base.

Could its enemies stop this work, or would it go forward to bring vast power to mankind? We give here a chronology of the fast-breaking scientific events which were leading up to a decision:

Winter 1819-20: The Danish researcher, Hans Christian Oersted, showed that a magnetic needle is deflected by the action of a current of electricity passing near it.

1820: Dominique François Jean Arago, a republican ally of Humboldt, discovered that an electric current passing through a wire wrapped around a piece of iron, can magnetize the metal.

1820: André-Marie Ampère, the French republican and universal scientist, discovered that two wires, through which currents are passing in the same direction, attract each other, and in opposite directions, repel. Ampère concluded that naturally occurring magnetism, as in iron, is due to electrical currents in the metal's molecules, and that the general laws of magnetism could be derived from electrical effects.

1825: Englishman William Sturgeon made an electromagnet by bending a thin iron bar into the form of a horseshoe, covering it with varnish to insulate it, and surrounding it with 18 turns of a bare copper wire. While current came from a small battery, Sturgeon's seven-ounce electromagnet supported a nine-pound piece of iron.

1829-30: The American Joseph Henry, in accordance with the theory of Ampère, produced the intensity or spool-wound magnet, insulating the wire instead of the iron bar, and covering the whole surface of the iron with a series of coils in close contact. To greatly increase the power of the magnet, Henry wound successive strata of insulated wire over each other, producing a compound helix, formed of a long wire of many coils. He perfected the electromagnet capable of transmitting power over a long distance, and was the first to magnetize a piece of iron at a distance.

1831: Henry's distinctive work in the discovery of induction was reported in *Silliman's Journal* in July 1831. His experiment involved opening and closing a circuit on an electromagnet, making the magnet induce a current in another coil.

In an 1832 article, Henry distinguished his work from that of England's Michael Faraday. Faraday had simply moved a magnet away from and back next to a coil, and passed a wire near a magnet.

Henry reported that his own experiment, by contrast, "illustrates most strikingly the reciprocal action of the two principles of electricity and magnetism." And it led to his invention of the first electric motor, a simple see-saw like device:

a coil around a bar mounted on a fulcrum which rocked back and forth, alternately closing and breaking the circuit at each end of the bar.

He also applied "the results of my experiments to the invention of the first electro-magnetic telegraph, in which signals were transmitted by exciting an electro-magnet at a distance, by which means bells were struck in succession, capable of indicating letters of the alphabet."

1832: Henry increased the power going through his magnet until it could lift more than 3,000 pounds. Alexander D. Bache helped publish and circulate Henry's work in Europe as well as in America.

1833: Astronomer-mathematician Carl F. Gauss and physicist Wilhelm Weber, working at Göttingen University in Hanover, excitedly took up the leads provided by Henry's experiments.

Gauss was, at the time, certainly the world's leading scientist, and the ablest contemporary defender of Gottfried Leibniz. Gauss had served as an adviser to the United States Coast Survey since 1819, and was ardently pro-American; three of his sons emigrated to the United States.

Wilhelm Weber, Gauss's working partner, discovered that the conducting wires of an electric telegraph could be left without insulation, except at the points of support. Gauss arranged the application of a dual sign in such manner as to produce a true alphabet for telegraphy.

Weber and Gauss built and demonstrated the world's first long-distance telegraph. Gauss wrote to the astronomer Heinrich Olbers, on Nov. 23, 1833, that their telegraph was "conducted through wires stretched through the air over the houses up to the steeple of St. John's Church and down again, and connecting the observatory with the physics laboratory . . . about eight thousand feet." The telegraph was operated in the presence of the king's brother, the duke of Cambridge. The first public notice of the telegraph was given by Gauss in the *Göttingische gelehrte Anzeigen* on Aug. 9, 1834.

On Aug. 6, 1835, Gauss wrote to astronomer Heinrich Christian Schumacher: "Could thousands of dollars be expended upon it, I believe electromagnetic telegraphy could be brought to a state of perfection and made to assume such proportions as almost to startle the imagination. The Emperor of Russia could transmit his orders in a minute, without intermediate stations, from Petersburg to Odessa, even peradventure to Kiachta [in Siberia, then on the Russo-China border], if a copper wire of sufficient strength were conducted safely across and attached at both ends to powerful batteries."

As a practical step toward implementation of such a Grand Design, it was proposed that the railroad initiated by Friedrich List should install the Weber-Gauss telegraph along the line. Gauss and Weber both wrote memoranda to the directors of the Leipzig-Dresden railroad, and negotiations commenced.

Some years earlier, Humboldt had introduced Gauss to Weber, and had suggested to Gauss that he interest himself in electricity—with spectacular results. What the British Empire and its allies feared the most, an uncontrollable breakout of technology and cooperative national development, was clearly in the offing.

Gauss, Weber, and Franklin's 'emanation'

A.D. Bache and Joseph Henry set sail for Europe on Feb. 20, 1837; they would wend their separate ways in Britain and on the continent. Bache would arrive in Berlin in December, on his way to Hanover. But before he arrived, the British would overturn the Hanover government and provoke a deep crisis.

In June 1837, William IV, king of England and of the German state of Hanover, died and was succeeded by his niece Victoria. But the sixth century Salic Law, in force in Hanover, disallowed female monarchs, and William's brother, Ernst August, became king of Hanover.

Ernst August was a true son of mad King George III. In 1810, he was suspected of having murdered his valet Sellis, perhaps over a blackmail problem arising from Ernst August having allegedly sodomized him; but he extricated himself from that difficulty when two men were imprisoned for accusing him of the murder. He was hated by the English people. And despite his German name and ancestry, the English-born Ernst August spoke not a word of German. British Empire policy needed such a one to do a dirty job.

Over Sept. 12-20, 1837, Göttingen University celebrated its jubilee, with Carl Gauss hosting Alexander von Humboldt at Humboldt's alma mater. Students were said to have been deeply moved by the greatness of these men and their work, and inspired to use their talents "as honestly and as restlessly" as the humanist scientists.

But King Ernst August had been to Vienna to consult with Prince Metternich. And on Nov. 1, Ernst August revoked Hanover's 1833 constitution, which had acknowledged the representative assembly and other civil and moral norms; citizenship was replaced by subjection.

For the British, this action came none too soon. During that same month, Friedrich List submitted a proposal to the king of France for the development of a grid of railroads and a national banking system—a giant step toward an anti-British Europe. List had started work in Paris on his magnum opus, the *National System of Political Economy,* attacking Adam Smith, contrasting the American and Colbertiste concepts of physical production with the pure exchange of free trade, and emphasizing the needs of nations against Smith's imaginary "cosmopolitan" world of consumers, in which no nations exist. A veritable war broke out within the French government over the List memorandum, sometimes resulting in fistfights.

In British-ruled Hanover, there was the expected popular outrage. Among the protests against the destruction of Hanover's liberty, was a petition signed by seven prestigious Göttingen professors: physicist Wilhelm Weber, Gauss's research partner; theologian Heinrich Ewald, Gauss's son-in-law; the brothers Jakob and Wilhelm Grimm, philologists and famous storytellers; and three other teachers.

On Dec. 7, 1837, Bache took up temporary residence with Alexander von Humboldt in Berlin. Bache's anticipated visit to Göttingen University, under Humboldt's sponsorship, would retrace the steps of Bache's great-grandfather, Benjamin Franklin, 71 years before. Franklin had come to Göttingen in triumph, just after his showdown in Parliament over the Stamp Act.

Alexander D. Bache's own high status and heart-felt reception in Germany, was reflected in an anecdote later told by Joseph Henry: "An elderly savant, on being introduced, clasped him in his arms, saluted him with a kiss on either cheek, and [said,] '*Mein Gott,* now let me die, since I have lived to see with mine own eyes an emanation of the great Franklin!' " Bache's planned visit to Göttingen would occur in the same politically charged environment of scientific achievement and global political tension as had that of his ancestor.

On Dec. 12, the seven Göttingen professors who had signed the petition against revocation of the constitution were expelled from the university; three of them were ordered into exile. King Ernst August sent troops to surround the university to prevent demonstrations.

In January 1838, Bache arrived in Göttingen, now under the British terror. Bache met with Carl Gauss and the expelled Wilhelm Weber, and it is known that they discussed the progress of electrical science and the telegraph, among other topics.

But the British crackdown crushed the active experimental collaboration of Gauss and Weber. The pogrom against Gauss has been pursued by the British Empire science establishment up until the present day. Indeed, the expulsion of the Göttingen professors went a long way toward neutering the academic world across the globe. In fields as seemingly diverse as mathematics, physics, philosophy, history, and economics, it became increasingly unsafe to stray from Newton, Locke, and company. As King Ernst August told Alexander von Humboldt, "For my money I can have as many ballet dancers, whores, and professors as I want."

The 'Lazzaroni' create a military-scientific complex

The heat of adversity and oppression had forged strong bonds of friendship between Bache and the greatest European scientists. This relationship would be the backbone of American science in its most important advances for the remainder of the century.

Bache recruited a handful of scientific associates, of undoubted loyalty, patriotism, and genius into a small junto, called among themselves the *Lazzaroni* (Italian for "beggars"). With strong working ties to Gauss and Humboldt, they set out to create a military-industrial complex which could guarantee the defense of the republic. America's powerful Navy, and her steel and electrical industries, were among the direct accomplishments of the *Lazzaroni* and their closest allies over the next 40 years.

Participating in Gauss's international organization to measure the earth's magnetism, the *Magnetischeverein,* Bache resumed his observations at Philadelphia's Girard College. In 1840, he hired an assistant, Philadelphian William Chauvenet, a recent Yale graduate and accomplished Classical pianist. Bache and Chauvenet would found the U.S. Naval Academy within a few years.

Bache published, in 1839, his immense *Report on Education in Europe,* on the elementary, secondary, technical, and military schools in Scotland, England, Prussia, Saxony, Bavaria, Austria, Switzerland, France, and Holland. Between 1839 and 1842, he reorganized the Philadelphia public schools, taking guidance particularly from the Prussian schools that he had closely studied.

Bache and his friends now saw their national mission in terms coherent with Leibniz's "Academy" proposal. Addressing an 1842 Exhibition of American Manufactures at the Franklin Institute, Bache spoke of industrial America, a new civilization, bypassing the mere trading centers, such as the formerly powerful Venice, whose wealth had been "lavished to decorate the homes of the merchant nobles." Bache proposed to consider, beyond any subject of partisan debate, "the means employed in different countries for the promotion of manufacturing and the mechanic arts, and of the intellectual improvement of their cultivators."

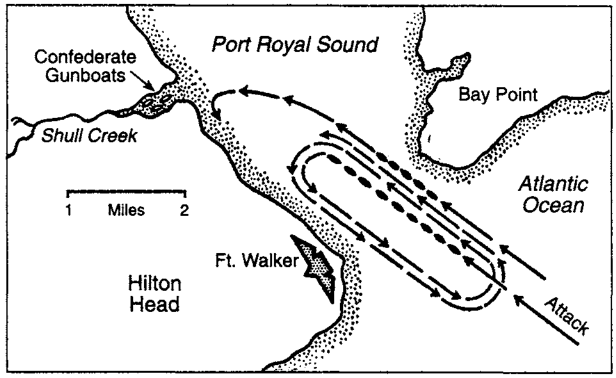
He lauded the "great scheme" of the *Zollverein,* within which the Prussian state encouraged silk culture, porcelain manufacturing, metal foundries, and sugar beet production; licensed and examined the skills in trades and occupations; promoted inventions; published technical journals; and trained the young without cost as machinists, metal founders, architects, builders, and engineers. He constrasted Britain's closed, "competitive" society, which fearfully barred all significant public interchange of technology.

Bache spoke bluntly of America's most powerful advantage over the Old World:

"The low wages of operatives generally in Europe, low relatively to the prices of conveniences, tends to keep the mass of them from intellectual improvement. Their youth is passed before they can judge of the necessity for culture, and [later adult responsibilities] . . . press on them so heavily, that they have time to think of little else. Until the means of life are more uniformly distributed, the mass of the mechanical population of Europe cannot become intellectual. The advantages of a different system of things, which exists with us, we should never lose sight of—never let go."

Nicholas Biddle appointed Bache to be the principal of Central High School in Philadelphia, and Bache built it into the first great public secondary school in America, the model

Gaussian mechanics and U.S. naval warfighting



Captain Charles Henry Davis, Bache's chief assistant at the U.S. Coast and Geodetic Survey, was a leading collaborator of Carl F. Gauss; Davis translated Gauss's seminal work on the calculation of celestial orbits into English. Davis introduced a new principle into warfare which led to a vital Union success early in the Civil War: the capture of Port Royal, South Carolina, in November 1861. Davis, fleet chief of staff under Adm. Samuel F. du Pont, developed an "expanding ellipse formation," which permitted what was then the largest U.S. fleet ever assembled to capture the two forts protecting Port Royal. This reversed the standard theories which held "that one gun on land was equal to four on water." As detailed by David D. Porter in his *Naval History of the Civl War,* this action opened the gateway to the capture of other Rebel cities such as New Orleans.

Admiral du Pont divided his fleet into a main squadron of nine heavy ships and a flanking squadron of gunboats. The two columns passed midway between the forts. The main force turned about in the sound and plied a narrow ellipse between the two forts until their fire was reduced by the naval bombardment. The ellipse was then expanded so as to bring the naval guns closer to the forts, increasing the effect of the artillery.

This was not the only application of Gaussian elliptic functions and celestial mechanics to naval warfighting. Admiral Porter utilized the mathematical hydrodynamics which had been taught to him by Davis's Coast and Geodetic Survey, in his successful navigation and conquest of the Mississippi with General Grant.—*Charles B. Stevens*

for all others. Bache established at Central High the nation's best-equipped astronomical observatory; Central High's astronomer, Sears Walker, quickly taught Bache's magnetic-observatory assistant Chauvenet the most advanced methods of the German astronomers.

In 1842, Commodore James Biddle, brother of Nicholas Biddle, made William Chauvenet head of a school that had been informally established within the Philadelphia Naval Asylum, the elderly seamens' home under Commodore Biddle's command. With Bache's help, the 22-year-old Chauvenet put old and young sailors through sophisticated courses in geometry, astronomy, and other navigational sciences.

In 1843, Bache was appointed head of the United States Coast Survey. He made the survey into a school for geodesy and hydrography for the entire military establishment, and the powerful base through which the federal government recruited and trained scientists. The work on oceanography under Bache (continuing the field developed by Alexander von Humboldt and by Benjamin Franklin), and mapping of the entire coastline, would allow the Union to impose a powerful blockade on the South during the Civil War.

Also in 1843, the U.S. Congress, under Henry Clay's close control, financed the implementation of Samuel F.B. Morse's telegraph (Morse had invented a good code, but only reluctantly conceded that he had not "invented the telegraph"). A.D. Bache and Sears Walker then developed the method of longitude computation by telegraph.

In 1845, Bache and his allies prevailed on the government to move William Chauvenet's naval school from the Philadelphia Asylum to the Army's Fort Severn in Annapolis, Maryland. Navy Secretary George Bancroft appointed Anglophile Cmdr. Franklin Buchanan to be superintendent; Buchanan later joined the Confederacy in the Civil War. But William Chauvenet continued in charge of the school's instruction and overall organization. He taught astronomy, navigation, geometry, and other mathematics; he and the nationalist Commodore Matthew Perry were the school's principal overseers. Before long, the name was changed to the United States Naval Academy.

Anti-nationalists had blocked the Academy's birth since it was proposed by Alexander Hamilton in 1799. But Bache's patriotic *Lazzaroni* scientists were too powerful, even taking over Harvard and Yale. It was also helpful that Bache's uncle, George M. Dallas, was U.S. vice president, and that Treasury Secretary Robert Walker was Bache's brother-in-law.

The Smithsonian Institution was founded in 1846, due principally to John Quincy Adams's fight for it. On Bache's recommendation, physicist Joseph Henry was appointed Smithsonian chief. Henry created the modern weather service, based on reception of reports by telegraph.

Meanwhile, *Lazzaronian* Benjamin Peirce founded the Harvard Observatory, and Harvard's Lawrence Scientific School; Yale's Sheffield Scientific School was created by Bache-ites Oliver Wolcott Gibbs and Benjamin Silliman, Jr.

During the Civil War of 1861-65, Bache was the recognized chief of America's scientists, with his *Lazzaroni* at the center of military strategy and intelligence. President Lincoln often consulted with Joseph Henry, and enjoyed rolling up his sleeves to help Henry at his experiments.

At the outbreak of the war, the President asked four men to sort out the loyalties of the naval officer corps: Alexander D. Bache; *Lazzaronian* Adm. Charles H. Davis, chief translator of Carl Gauss into English; Adm. Samuel F. du Pont, close collaborator of Bache and Davis; and Commodore Hiram Paulding. These men later swung the decision to produce the new *Monitor* ironclad warship.

National institutions had thus been formed, beginning in the 1830s, that could sharply upgrade U.S. technical competence and power. But radical free-trade dogma had dominated Congress and the Presidency; manufacturing was suppressed, and by the late 1850s, slave-grown cotton had become the leading product and export of the United States. By the time the slave owners' rebellion started the Civil War, the country was utterly bankrupt. New national life would come from Abraham Lincoln's revolution in economic strategy, as well as his war leadership.

5. Why Lincoln built the nation's railroads

During the Civil War, American armed force reunited the country. At the same time, President Abraham Lincoln ended and reversed the rule of "free trade" or "laissez-faire," by which the London-allied opponents of the American Revolution had expanded plantation slavery to the detriment of American industrial power.

Lincoln's breathtaking economic development program, begun when the country was bankrupt, continued in effect at least long enough after his assassination, for the United States to make itself the world's greatest industrial power. Lincoln's measures remained in force for several decades, controlling inflation through industrial innovation, and raising U.S. living standards to unprecedented heights.

Abraham Lincoln's economic program as President cohered with his long political career as a partisan of nationalist leader Henry Clay (1777-1852), and a follower of Philadelphia economist Henry C. Carey (1793-1879).

From the late 1840s until several decades after his death, Henry Carey shaped the thinking of nation-builders throughout the world. In his widely translated books, Carey demonstrated that the free trade proposed by the "classical" school of economics was cheap British imperial propaganda. Henry Carey assumed personal leadership of the nationalist political-industrial-scientific complex in Philadelphia, that was the backbone of support to Lincoln as President. After the Civil War, this "private" apparatus, overlapping with the government and the military, would create huge, new American industries under government protection and subsidy.

Carey and his allies formed the Republican Party in the mid-1850s. As the party's 1860 Presidential candidate, Abraham Lincoln asked Carey to write his campaign's economic platform; it was a "statist" proposal, for protectionist tariffs to revive American industry. As President, Lincoln asked Carey to pick some significant Treasury Department appointees, so that the free trade policy of the slave owners could be erased completely from national government practice.

While President Lincoln built the world's most powerful armed forces, he put through an extraordinary program of economic measures, including:

- ultra-protectionist tariffs which virtually forced into existence a new American steel industry;
- government organization of railroad systems reaching across the wilderness to the Pacific Ocean;
- the sharp upgrading of U.S. agriculture, by such methods as government-directed agricultural science, free land for farmers, creation of the Agriculture Department, and promotion of new farm machinery and cheap tools;
- recruitment of immigrants, to rapidly increase population;
- free higher education throughout the United States through the Land Grant College system;
- reestablishing national control over banking, with cheap credit for productive purposes.

In this report we will focus on the railroad project and the creation of modern agriculture, which we chose in order to correct popular prejudice: that railroads were built by "robber barons" (in truth, they only stole them after they were built), and that government support for farmers is a "giveaway" (the government actually created the private family farm in America).

When Lincoln's first transcontinental railroad was completed in 1869, the 1,776 miles of new track took passengers and freight across mountains and desert from Iowa to California. Historians usually ascribe the building of this railroad, which immensely strengthened the United States, to such historical facts as the withdrawal from Congress of its Southern opponents. Abraham Lincoln's unique, lifelong, personal identification with the fight for Western development, is covered over with contemptuous, patronizing remarks, from Lincoln's ostensible supporters, and charges of corruption from his obvious detractors.

When President Andrew Jackson (1829-37) broke the Bank of the United States, and halted national support to road,