EIR Feature

Leibniz, Gauss shaped America's science successes

by Anton Chaitkin

This report continues the story begun in the Dec. 1, 1995 *EIR,* "The Anti-Newtonian Roots of the American Revolution." That earlier segment demolished the myth that the American Revolution was inspired by "Enlightenment" British philosophy associated with Isaac Newton and John Locke. It showed, rather, that the British monarchy and its Empire were the principal enemies of the U.S.A. from colonial times to the twentieth century, due to a fundamental conflict over political and moral philosophy.

Benjamin Franklin (1706-90) and his circle carried on the war of ideas and statecraft that had been led by the German Platonic philosopher Gottfried Leibniz (1646-1716). These Americans, the heirs of Leibniz, opposed the imperialism, atheism, and irrationality of Britain, and of Locke and Newton, in politics and science alike. With Leibniz, they rejected Newton's dead universe and Locke's demand that property must dominate man. They made a Constitution and a government with the power to promote revolutionary technological change and improvement of man's condition.

The present report takes the story of this conflict from the eighteenth through the nineteenth century, to show how these Americans and their allies created "modern times"—in the face of bitter opposition from the British Empire. The question of how this came about—what is the origin of modern industry, modern agriculture, and the living standards achieved in the industrialized countries—is of particular current urgency: The world is in danger of losing the profound advances civilization has made, and falling into backwardness and brutal chaos.

After the fall of the communist system, Margaret Thatcher and George Bush rushed in to eastern Europe and Russia demanding that all government enterprises be sold off and living standards be slashed. They claimed that the only alternative to this "free market" savagery would be communism or some other tyranny. The result was catastrophic: Production collapsed, and millions have died as the death rate soared. And yet it is still almost universally believed in eastern Europe that the

America was founded on a conceptual blueprint provided by Gottfried Leibniz (left), the great German statesman, philosopher, and scientist. Leibniz proposed that government sponsor research, advanced manufacturing, and the elevation of workers' minds as the principal theme of national life. This way of thinking defined the "American System" of Benjamin Franklin (center) and informed the scientific work of Thomas Alva Edison (right).

"free market" caused the success of Western society.

In America, the spokesmen for this British line—Newt Gingrich and company—press ahead with their economic wrecking operation, while invoking the Founding Fathers. The Gingrichites assert that the West became powerful simply by preventing government from interfering with the unbridled quest for private financial gain.

This absurd fiction is promoted by both the radical free marketeers and the communists. Karl Marx (writing under British auspices) claimed that a so-called "capitalist class" had invented all modern technology, and that *their freedom from moral and legal restraints had allowed them to do so.* The adherents of Adam Smith, including right-wing populists, agree completely with the communists about this ridiculous story.

The classic historical writing in support of this theory is mere bluff and bluster. The basic facts of the industrial revolution and the political war over its accomplishment are simply omitted.

Two centuries ago, there were no industrial nations on this planet. No country had any factories in the modern sense, no machines powered by artificial means, no industries run on scientific lines. The West did not *gradually* become industrialized. Rather, there were suddenly very distinct bursts of invention, sharply defined periods of growth, that radically changed the life and work of society. In Britain, this rapid change began in the 1760s and was frozen in place by the turn of the century. In America, the great transformation took place in two phases, from the 1820s to the 1840s, and again to a higher level from 1861 into the 1880s.

All of these advances, and the modernization of continental Europe and Japan in the nineteenth century, were *deliberate projects for the improvement of humanity.* No credit belongs to the "magic of the marketplace," or to the magicians in London and their Wall Street clones, who opposed these developments. All the great breakthroughs in technology and living standards were guided by an alliance of Americans and Europeans centering on Benjamin Franklin and his party over three generations. The industries were created under government sponsorship and protection.

In the following pages, we will see:

- Leibniz's proposal for the Academy (later copied by Franklin's American Philosophical Society): his startlingly advanced educational, scientific, and industrial policy, by which America changed the world;
- England's industrial revolution, organized by Franklin and his friends;
- The nationalist leadership that revived Franklin and Alexander Hamilton a generation after the Revolution, and the State-sponsored first phase of America's industrialization;
- Cooperation between the American nationalists and the European scientific elite led by Carl F. Gauss, in a showdown with the British royal family over electricity and national destiny;
- Abraham Lincoln's statist economics, and his revolution in transportation;
- Lincoln's European-bred scientific agriculture, to make family farmers "independent of crowned-kings, money-kings, and land-kings";
- The nationalists' drive for worldwide industrialization, in a war with Britain's murderous sabotage; the inside story of the Edison project, and the birth of "modern times."

1. Leibniz's plan for the American System

by Jonathan Tennenbaum

Contrary to the myths which fill most history books these days, the institution of the *modern industrial nation-state*—as exemplified by the United States from the nineteenth century up into the 1960s—did not emerge by itself in some spontaneous fashion, but was deliberately *created* by groups of individuals who acted according to precisely conceived policies and principles. In fact, the founding of what was to become the world's most powerful industrial nation-state, by Benjamin Franklin, Alexander Hamilton, and others, was based on a kind of *plan,* a conceptual *blueprint* which had been provided in advance. Although the fundamental principles involved can be traced back to the fifteenth century Renaissance, the immediate initiator and architect of the conspiracy which produced the United States and the "American System" of political economy, was without doubt the great German statesman, philosopher and scientist Gottfried Wilhelm Leibniz (1646-1716).

Leibniz's efforts extended far beyond the American colonies or any other particular region of the world of his day. His was a Grand Design to defeat the forces of oligarchism and barbarism worldwide, and to uplift humanity as a whole, by fostering everywhere the development of sovereign nation-states based on scientific and technological progress. To realize this Grand Design, Leibniz organized and directed what can only be described as one of the greatest worldwide conspiracies of all time, extending from China and Russia, throughout Europe, and into the New World.

Leibniz's national academies

The kernel of Leibniz's "blueprint" for the American System is contained in a series of memoranda spanning the period from 1671 to 1716, where he proposed the establishment of what he called "Societies" or "Academies" in various nations. As the following quotes make clear, Leibniz meant something entirely different from mere scholarly associations, of the sort the term "academic" would tend to suggest today. Leibniz intended the "Society" in each country to be the locomotive and organizing center of a rapidly-developing *national economy,* in direct opposition to the ruinous "free trade" policies of the Venetian-Anglo-Dutch oligarchy. Already in his early memorandum "Economy and Society," written in 1671, Leibniz is explicit about his political intentions:

"Thanks to these academies (or societies), which are institutions of research and of development, with their own manufactures and commercial companies directly attached, the monopolies will be eliminated, because the academy will always offer a just, low price for merchandise; and quite often, in fact, these will become even less expensive, as new manufacturing activities are set up, where they do not presently exist. Notably the trading monopolies will be eliminated . . . because the wealth of the traders is much too great, and the misery of the workers far too profound—a situation seen particularly in Holland, where the method of the merchants is to maintain the workers in a state of poverty and menial labor. . . . Trade cannot transfer anything which has not before been produced by manufacturing. And why must so many people be reduced to such poverty, for the sake of so few? The Society will therefore have as its goal to liberate the worker from his misery."

In stark contrast to the bestial immorality preached by Hobbes, John Locke, and later Adam Smith—apologists of the British "free market" doctrine of the "law of the jungle"—Leibniz based his plan for the "Society" explicitly on the concept of man as "imago viva Dei," whose creative powers permit him to participate, in the image of the Creator, in the ongoing development of the Universe. In a beautiful memorandum setting forth the moral purpose of the "Society," Leibniz puts forward his notion of "the pursuit of happiness" which will later inspire the framers of the U.S. Constitution:

"[To] not only seek the majesty of God in Nature, but to imitate it; and therefore to honor Him not only in praises and prayers, or with words and thoughts, but also by Good Works; not only to contemplate the good He has done, but to devote and offer oneself to him as an *instrument,* and thereby to accomplish more good to the world and especially to the human race, since Man is the best in all visible Creation, in which we have the power to work. . . .

"To apply the discovered wonders of Nature and Art to medicine, to mechanics, to the convenience of life, to provide the materials for work and nourishment to the poor, to preserve people from idleness and corruption; to provide justice, rewards and punishments, to insure public order, to promote the good of the Fatherland, to eliminate times of scarcity, pestilence and wars; to do everything we ought and which is in our power, to spread the True Religion and the fear of God, and indeed to provide for the *happiness of the human race,* endeavoring in our own domain to imitate what God has done in the universe as a whole."

It is in terms of this higher goal that Leibniz outlines the principles of national economy, which Alexander Hamilton will later set forth as the official economic policy of the United States, in the latter's 1791 "Report on Manufactures." What Leibniz outlines, in concentrated form, is the kernel of the "American System" policy for rapid industrial development, through the "dirigistic" promotion and protection of domestic manufactures, science and education. Leibniz clearly identifies the key role of steam power in increasing the productive powers of labor—a development he took a leading role in initiating and promoting. In one of his memoranda, written

around 1671, Leibniz lays down the economic policies of the "Society" as follows:

From 'ideas,' to national industry

"To Expand and Improve the Arts and Sciences.

"To preserve useful ideas, inventions and experiments . . . and to verify them with the help of models and tests; or if verified, to exploit them on a larger scale, than a private person could do.

"To combine Theories and Experiments, to remedy the defects of the one with the other.

"By putting together various experiments and inventions, to render useful that which is isolated and incomplete. . . .

"To provide poor students the possibility to support themselves in order to continue their studies, and to earn their bread, for their own advantage and for the benefit of the Society. . . .

"To improve the Schools. Therein to introduce curricula, correctness and standards. To educate the youth not only in Poetry, Logic and Scholastic Philosophy, but also in Realia: History, Mathematics, Geography, Physics, Morals and Civil Affairs.

"To set up Museums of Arts and Rarities, of Weaponry and Anatomy, unknown Medicines, Animals, and a Theater of Nature and the Arts, in order to provide lively Impressions and Knowledge of all things. . . .

"To Improve Manufactures

"With advantages and instruments to make work easier. To have constant fire and motion [the steam engine!—JBT] as the foundation of all mechanical action, Making use of all new ideas and and concepts, Testing our own and those of others, And therefore not to drag behind.

"To bring into the country, and develop the existing stock of: mills, lathes, glass grinding and polishing, all kinds of machines and clockworks, water works, shipping, painting and all figurative arts, textile mills, glass-blowing and forming, dyeing factories, medicinal arts, steel and other metallurgical production, chemistry. . . ; to make better use of the mines, and in general to help the laboring people with many other useful inventions: those already existing, those we can obtain, and those we may hope to obtain. . . .

"To Improve Trade

"To bring food into the country, To keep people in the country, To bring more people in, To create manufactures here, And draw in commerce, To gradually eliminate undesirable foreign manufactures, without banning them. . . . To never let raw materials leave our country unprocessed, To process foreign raw materials in our country. . . .

"To set up warehouses and shops, supplying ourselves in good time with all kinds of articles, never to be lacking in necessary things nor to wait for an emergency, and thereby to prevent famine and increases in price. . . .

"To set up a secure bank for investors to invest their monnies. According to opportunities, to form new companies, and to acquire stocks in existing ones. . . .

"To obtain more from lended monnies, than the rate of interest. . . .

"To grant Priviledges inside the country for everything, that excludes foreign priviledges, and this without making anything more expensive.

"To obtain Priviledges outside the country for all activities and manufactures that are new, and have not yet been realized or produced.

"It is therefore to be achieved, that we be able to produce everything better here, than elsewhere, in such a way that we can exclude them [foreign manufactures] without Priviledges, but by the favorable cost of all manufactures, provided only that the effort be undertaken, to produce them more economically, than [abroad].

"To conserve and expand the Fund by a continuous Circulation, and to undertake all enterprises that are pleasing to God, useful to the Fatherland, and bringing honor to the Founders, to ever greater and higher ends."

In these brief lines we can already see the kernel of the monetary and credit policies developed by Franklin, Hamilton and others, which had as their goal and criterion the expansion of the real wealth of society through scientific and technological progress.

2. The Franklin circle starts modern England

by Anton Chaitkin

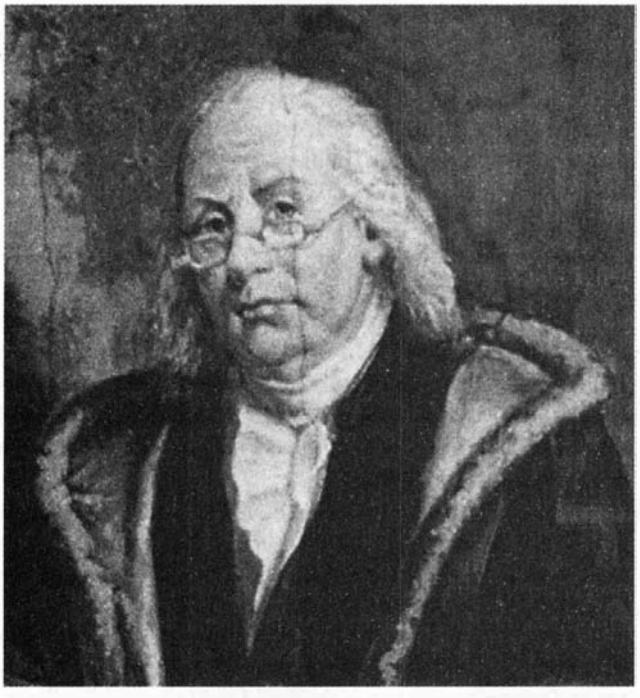
Editor's note: All the remaining sections of this Feature *are also by Anton Chaitkin.*

Benjamin Franklin sailed to England in the spring of 1757, the official political representative of the British colony of Pennsylvania. It was 19 years before America would declare its independence from the British Crown.

When Franklin took up residence there in July 1757, Great Britain was very backward. There were virtually no roads between cities, no canals, and no railroads. Iron, cloth, or grain could only be shipped overland in the saddlebags of a packhorse, and this only when there was relatively little mud. All manufacturing took place on a small scale by local operatives or in rural homes. London was wealthy from world trade and finance, but it was the capital of an undeveloped country.

The project to industrialize Britain, begun shortly after Dr. Franklin's arrival, was initiated by a small circle of his collaborators, and was carried to fruition under his leadership.

It was then the last few years of the reign of King George II. The king's grandmother, Electress Sophie of the German



Detail of a portrait of Benjamin Franklin in the U.S. Capitol. Britain's "industrial revolution" began in 1758-75, with England's first canal-building, the invention of steam power, and modern chemistry and steel making. All this was organized by Benjamin Franklin and his close circle of friends.

state of Hanover, had been the protector of the philosopher Gottfried Leibniz. Her succession to the English throne was arranged by Leibniz and his allies, the pro-American republican circles of Irish statesman and author Jonathan Swift. But Sophie had died too soon, and her intended English crown was taken by her boorish son George I, a tool of the British Empire "Venetian party," the oligarchy that ran the slave and opium trades. George I died in 1727; his son George II, who died 1760, was succeeded by the infamous George III.

The Leibniz-Swift faction had crumbled in England; the imperial cabinet was run by Nero-like members of the openly Satanic "Hell-Fire Club." This government was now forbidding the American colonies to develop manufacturing, or to expand to the west. Franklin was determined to create a thriving agro-industrial America, as the necessary basis for eventually securing independence. If some kind of manufacturing could be started here in the center of the British Empire, it would be that much harder for the ruling clique to snuff it out generally.

Franklin was already famous in England, and feared by the government, as a scientist and political leader of the colonists. His published experiments had clarified the nature of electricity. He had created the American Philosophical Society, the first organization uniting the colonies in any fashion; its subcommittees were now at work planning the creation of (illegal) native industries.

Corresponding with a worldwide circle of sympathetic leaders in science, art, religion, politics, and the military, Franklin was chief of intelligence for the American nation, then in the process of its creation.

Though its results were to be of spectacular benefit to the general population, the project we report on here, was at times subject to extreme harassment, and had to be carried out with great caution, even secrecy. We report what is known of Franklin's movements and contacts in the opening phase of the project.

Franklin obtained an introductory letter from Cambridge University Greek and Hebrew professor John Michell, a pioneer seismologist, astronomer, and magnetic scientist. Michell's letter addressed to Matthew Boulton, Jr., son of a buckle manufacturer: "to introduce . . . the best Philosopher of America, whom you are already very well acquainted with though you don't know him personally."

No later than the summer of 1758, Benjamin Franklin and Matthew Boulton, Jr., began joint work on electricity, metallurgy, and the harnessing of steam power. Their collaboration, at times surreptitious and subject to police surveillance, continued until Franklin's death in 1790. Franklin became the inspiration, tutor, science adviser, and political counselor to a select group of Boulton's friends in Birmingham, including potter Josiah Wedgwood, and Boulton's physician, Erasmus Darwin.

The industrialization of Manchester

The first task of the Franklin circle was to create an industrial city, with access to cheap fuel. In the process of building Manchester, England's first industrial center, the Franklin associates would initiate low-cost transportation for all goods, the *sine qua non* for an industrial nation. For these purposes, they would use a young, sympathetic, but not very wealthy duke of Bridgewater, whose estate came to be managed by the Franklin circle.

John Gilbert, a former apprentice in the shop of Matthew Boulton, Sr., and a lifelong intimate of his son, was hired in 1757 as the manager of the duke of Bridgewater's lands and coal mines at Worsley. Gilbert's brother, Thomas Gilbert, was already estate manager for the allied Bridgewater and Gower families.

In that year of 1757, the 21-year-old Francis Egerton, Third Duke of Bridgewater, came into possession of his inheritance, which included lands in London, and the Worsley estate located in an agricultural area some ten miles west of the market town of Manchester. John Gilbert convinced the new owner to cut a canal from the coal mines eastward to Manchester. Studying the layout of the mines and the land to the east, Gilbert turned the perennial problem of mine flooding into a technologically unprecedented aid to navigation. He proposed that canal digging should commence underground, in the mine itself, and proceed out through the side

of a hill. Newly mined coal could thus be loaded directly onto barges, while the mine's drainage would help maintain water levels in the overland canal.

Manchester then had only about 6,000 houses, and no factories requiring coal for steam power, which did not yet exist. Wood was used for hearth fires throughout England. There was no "market" whose logic Bridgewater was obeying when he decided to pursue such a construction project; and there were no other canals in England. But the duke's imagination had been well prepared for this adventure. He had gone to Europe as a pupil and ward of Robert Wood, a passionate devotee of Homer and Classical Greek civilization. Wood tamed the teenaged duke's carousing, and immersed him in the works of the Renaissance Christian humanism. He learned engineering and science at the Lyons academy and studied Florentine painting in Rome. The young duke viewed the canals of Holland, and closely inspected the great Languedoc Canal across France. The Languedoc had been surveyed by Leonardo da Vinci (who died in 1519), but it was built by Colbert in the late 1600s, using locks designed by Leonardo.

Excitedly agreeing to John Gilbert's proposal, the Duke Francis devoted his life to the construction of canals. Preparations began secretly, with initial purchases of land into Manchester. An act was put through Parliament, for the right to compel landowners along the canal route to sell Duke Francis their property. The price of coal from the Worsley mines was fixed by law at no more than four shillings per hundredweight, compared to the pre-canal average price of seven or eight shillings. Freight tolls were also set by law, and manure was to be toll free on the canal.

The duke was not a "capitalist," but a heavily encumbered landowner: He exhausted his personal funds early in the construction effort. In order to raise funds, the Gilbert brothers sold very small denomination bonds to local merchants, while the duke borrowed from his tenants. No backing came from London banks. Indeed, there was no net profit in the enterprise for some 15 years, though Bridgewater eventually made a large profit on the canal system, after decades of labor. Duke Francis routinely paid fair prices to landowners displaced for the canal. He hired many coal miners, paid them good wages, and got decent living conditions for his workers in new cottages.

The canal was begun in 1759 and completed into Manchester in 1761. Thousands of people began moving into the city and starting families there, with a secure supply of cheap Worsley coal for warm houses. And there were well-paying jobs: with a new labor supply and cheap fuel, a great number of profitable new manufacturing shops were set up. A greatly expanded canal system, and steam-powered machinery, would before long complete the amazing, virtually overnight creation of an industrial center.

By 1790, workmen from the new textile mills could be seen walking Manchester's streets, five-pound notes protruding ostentatiously from their hats. Yet 50 years later, that very city was famed for the horrible poverty and cruelty in its mills, and for the so-called Manchester School of economic thought—the radical free-trade doctrine which claimed that the unrestricted freedom to do ill to one's neighbor was the *cause* of England's technical development, that poverty and misery resulted from new technology, not from the crime of those who had taken over in place of the inventors.

More canals, and nation-building power

After the success of the Bridgewater canal was demonstrated, the entire Boulton-Franklin group swung into action. A partnership of the duke, the Gilbert brothers, Josiah Wedgwood, Erasmus Darwin, and Matthew Boulton, was eventually formed to extend the canal from Manchester to the port of Liverpool, and then to push on to connect Hull, Bristol, and London.

Wedgwood's partner, Thomas Bentley, and Erasmus Darwin wrote pamphlets in an effort to expand the British people's aspirations towards economic progress. Josiah Wedgwood placed the following newspaper notice:

"That great genius and Father of his Country, the Czar Peter, being well informed of the extensive Utility of Inland Navigation to the Growth of Commerce, completed a Canal between Petersbourg and the Wolga, at an incredible Expence, thro' an uncouth and arduous Country. The States of Holland owe their very Existence, as well as their opulence and power, to their numerous Canals.

"And the French Nation, our Rival in Arts and Arms, have already much availed themselves by navigable Cuts of vast Extent, and of amazing Advantage to their Commerce . . . that of Languedoc is a most stupendous Work" (*St. James's Chronicle,* May 16-18, 1765 (transcription courtesy of the Trustees of the Wedgwood Museum, Barlaston, Staffordshire).

After feverish negotiations, planning and lobbying, a bill authorizing the cutting of the partners' canal to Liverpool was steered through the Parliament, ending in a Commons committee whose chairman was Thomas Gilbert.

Meanwhile, Benjamin Franklin had started the group on a new project—to coordinate the development of a practical steam engine: From London, Franklin wrote to Boulton (May 22, 1765) "to introduce my Friend" Dr. William Small, "to your Acquaintance . . . an ingenious Philosopher, & a most worthy honest Man" and to ask "if any thing new in Magnetism or Electricity or any other Branch of natural Knowledge has occurred to your fruitful Genius since I last had the Pleasure of seeing you, you will by communicating it, greatly oblige."

Small, a native Scot, had emigrated to Virginia in 1758 to take a science and mathematics teaching assignment at William and Mary College. There Dr. Small, the Platonist law professor George Wythe, their student Thomas Jefferson, and Gov. Francis Fauquier, formed a regular string quartet. Franklin's friendship with Dr. Small probably began in 1763

when Franklin visited Williamsburg, during his brief return to America. A hostile administration at the college soon afterwards forced Small to leave his post; Small and Franklin went to England in 1764. The following year, Small accepted Dr. Franklin's momentous assignment.

On Franklin's recommendation, Matthew Boulton instantly accepted William Small as his personal physician and overall industrial manager. Boulton had inherited a buckle-making shop upon his father's death in 1759. He then built what was to become England's first great manufacturing plant, the Soho works outside Birmingham, with power supplied—temporarily—by a water wheel. Now that Small had come from America, the pace of activity at the Soho plant increased dramatically.

In February 1766, Dr. Franklin gave his blunt testimony in Parliament against the notorious anti-American tax known as the Stamp Act. He warned that the British Empire would be destroyed if it persisted in looting the colonies. Parliament repealed the Stamp Act on Feb. 22, 1766, to the delight and applause of the world's republicans. On that same historic day, Matthew Boulton wrote to Franklin from Birmingham, asking for his comments on the steam engine which Boulton and Small had built and had sent to Franklin in London:

"The addition you have made to my happiness in being the cause of my acquaintance with the amiable and ingenious Dr. Small deserves more than thanks. . . . I [introduce] to you my good friend Mr. Samuel Garbett . . . a Zealous Advocate for Truth & for the rights of your oppress'd Countrymen. . . .

"My engagements since Christmas have not permitted me to make any further progress with my fire-engines but, as the thirsty season [i.e., the dry season when the water levels were too low to provide power to the factory] is approaching apace, necessity will oblige me to set about it in good earnest. Query,—which of the steam valves do you like best? Is it better to introduce the jet of cold water at the bottom of the receiver . . . or at the top? Each has its advantages and disadvantages. My thoughts about the secondary or mechanical contrivances of the engine are too numerous to trouble you with in this letter, and yet I have not been lucky enough to hit upon any that are objectionless . . . if any thought occurs to your fertile genius which you think may be useful, or preserve me from error in the execution of this engine, you'll be so kind as to communicate it to me. . . ."

Erasmus Darwin wrote to Boulton on March 11, 1766, inquiring what Franklin had thought of the model steam engine and what he had suggested to improve it.

Franklin replied to Boulton on March 19, "excuse my so long omitting to answer your kind Letter . . . consider the excessive Hurry & Anxiety I have been engaged in with our American Affairs. . . .

"I know not which of the Valves to give the preference to, nor whether it is best to introduce your Jet of Cold water above or below. Experiments will best decide in such Cases. I would only repeat to you the Hint I gave, of fixing your Grate in such a Manner as to burn all your Smoke. I think a great deal of Fuel will then be saved, for two Reasons.

"One, that Smoke is Fuel, and is wasted when it escapes uninflamed. The other, that it forms a sooty Crust on the Bottom of the Boiler, which Crust not being a good Conductor of Heat, and preventing Flame and hot Air coming into immediate contact with the Vessel, lessen their Effect in giving Heat to the Water. All that is necessary is, to make the Smoke of fresh Coals pass descending through those that are already thoroughly ignited. I sent the model last week, with your papers in it, which I hope got safe to hand."

Franklin here was addressing a central question in steam engineering. Certain primitive devices were already in use, involving hot water vapor, such as the Newcomen engine. But only a tiny proportion of the energy in the fuel was translated into delivered power. This problem was to be solved definitively at Soho.

The canal partners meanwhile pushed ahead. They at length prevailed in Parliament and were allowed eminent domain to build south, completing the link from Manchester to Liverpool. The new law required toll-free shipment of road-building materials, so that all the national transport facilities could grow simultaneously.

Boulton, the Gilberts, and Bridgewater now initiated canal projects all over England, and "canal mania" changed the face of the island. Britain converted at once to the use of coal from distant mines for fuel, instead of burning local stands of timber. The mass manufacture of iron and steel was now practicable.

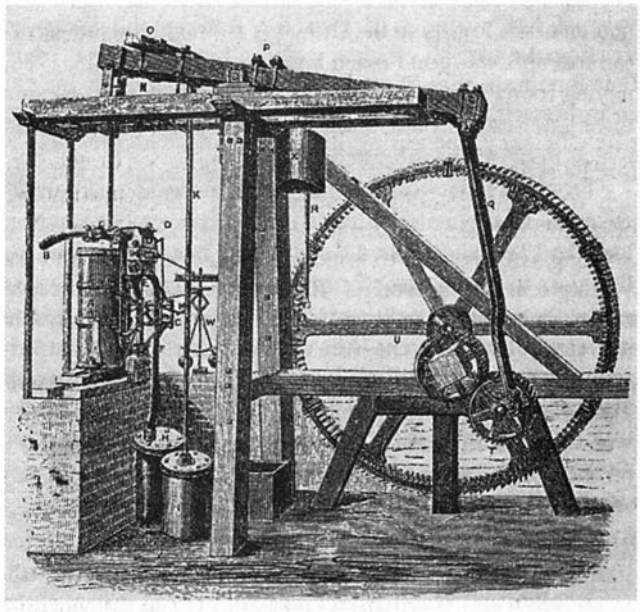
The world's first steam engine business

The Scottish mechanic-engineer James Watt was employed in 1767 to survey for the Forth and Clyde Canal. He went to visit the Soho works and met there with the manager, Dr. William Small. They talked of Watt's own recent experiments with steam power in Scotland. Dr. Small wrote to Watt, Jan. 7, 1768, proposing the creation of a new firm: "you should settle here, and Boulton and I assist you as much as we could. . . . I have no . . . doubt of your success, nor of your acquiring fortune, if you proceed upon a proper plan as to the manner of doing business. . . . I should not hesitate to employ any sum of money I can command on your scheme. . . ."

While working as scientific instrument-maker for the faculty at Glasgow University, Watt had studied French, German, and Italian, and had applied himself zealously to the study of music. He learned to repair violins, guitars, and flutes. He studied harmonic theory, and, in building first a model, and then a full-scale organ, he devised new means of regulating its stops, tuning, and air pressure.

Watt then studied the available French and Italian literature on steam research; he conducted rigorous experiments on gas dynamics.

While repairing a broken Newcomen engine, he conceived the separate condenser, the eventual basis of a practical



The Boulton-Watt rotative engine. Benjamin Franklin brought in Dr. William Small from Virginia to manage Matthew Boulton's Soho plant; Small hired James Watt, and Small oversaw construction of the first serious steam engine. The Boulton-Watt engine powered new industries designed by Franklin's circle.

steam engine. He led the steam away from the main cylinder, liquefied it with a cold jet, reheated and brought it back into action, while the cylinder could remain hot and do more work with less fuel.

As part of the negotiations to set up the world's first steam engine business, William Small prepared a patent for Watt, which was tentatively approved on Jan. 6, 1769. With constant encouragement by Dr. Small, Watt finally moved to Birmingham in 1774; the partnership of Small, Boulton, and Watt, under Small's patient and scientific management, pressed on and completed their first successful machine late that year. Watt was frequently depressed and despondent. Overthe years, his return to an active working role was several times revived by the pleas, threats, and rewards of Small and Boulton. The Soho group invested perhaps £50,000 in the development, with no real profits until the 1780s.

The Soho steam engine became the driving force for the English industrial revolution only after a last, crucial improvement was made. At first, the piston was packed with stuffing material, to close the gap with the cylinder wall and prevent the loss of steam pressure and force. The cast iron cylinder could never be shaped evenly for a tight fit around the piston. Boulton proposed to ironmaster John Wilkinson that his cannon-boring machine tool be modified to produce an engine cylinder.

Wilkinson's boring mill succeeded brilliantly, and Soho now made powerful, efficient steam engines, which Wilkinson used to run his furnace bellows, and to turn his machines. Here was the birth of many industries at once. Wilkinson produced all the tools and machine parts for Soho, and Wilkinson and Boulton jointly launched modern English copper mining. Ironically, English high-efficiency steelmaking, its origin closely identified with Wilkinson, Watt, and the Franklin republican circle, was later used by the British Empire as an instrument of nineteenth-century trade war against the American republic.

A great stride in chemistry

Ironmaster John Wilkinson's involvement with the Birmingham group arose on the basis of political and personal ties. His sister Mary and brother William were both pupils of the dissenting clergyman and schoolmaster, Joseph Priestley, who had married Mary Wilkinson in 1762. Priestley was to become celebrated as the discoverer of oxygen, after Benjamin Franklin made him a scientist.

The Wilkinson family, Thomas Bentley, and Josiah Wedgwood had patronized Priestley's early teaching career. The latter's devotion to reason and humanity led him to attack the government's church, and its modes of worship. He became a Unitarian and was perhaps theologically confused, but he remained a Christian, though he was to suffer greatly for it.

In December 1765, Priestley was introduced to Franklin in London. The American took the 32-year-old schoolteacher under his wing, and worked Priestley's nascent research interests into a passion for natural science as the most effective means for mankind's advancement.

On Franklin's request, Priestley wrote *The History and Present State of Electricity,* setting forth Franklin's discoveries in the field as the basis of further scientific work. The book lauded the genius of Italian physicist Giambattista Beccaria, whose precise experimentation and calculations had proven Franklin's theory of single-fluid, positive and negative electricity: "All that was done by the French and English electricians, with respect to lightning and electricity, fell far short of what was done by Signior Beccaria at Turin." Beccaria's follower Alessandro Volta later invented the electric battery after much collaboration with Priestley.

His book a success, Priestley was elected to the British Royal Society, on Franklin's nomination. Papers that the Englishman Priestley afterward wrote for that society were submitted for him by the American, Franklin, his political and scientific guide.

Priestley's work had immense global implications. He isolated the element in the air which supports life through respiration. He discovered how plants use the products of respiration; that plants renew the breathable element; and how light causes the growth of plants' green substance.

The Anglophile establishment has falsely identified Joseph Priestley with the methodology and general outlook of nineteenth-century radicals such as the degenerate Jeremy Bentham. In 1775, when war was breaking out with the American colonies, Priestley was subjected to a campaign of slander as a purported plagiarist. Bentham joined that attack with

his own criticisms of Priestley.

The scientist replied to a Bentham proposition that the friction of clouds causes lightning. Priestley said, "He will excuse me if I observe, that I find no sufficient *friction* to produce electricity in the manner that he supposes. The motion that is perceived in small clouds during a thunderstorm seems to me to be the *effect* of preceding electricity."

In 1780, he became in effect a paid staff member of the Boulton group, collaborating with Watt, Wedgwood, and others on diverse technical projects.

During a 1774 tour of continental Europe, Priestley met Antoine Lavoisier, and told the great French chemist of his discoveries regarding life processes. Lavoisier later gave the name "oxygen" to Priestley's breathable element, and developed the chemical science of combustion.

Franklin depended heavily on Lavoisier to help swing the French decision to arm and ally with the Americans, in their War of Independence. Lavoisier's chemistry was essential for the successful manufacture of the gunpowder behind the American bullets. Lavoisier was beheaded during the French Revolution Reign of Terror.

The end of the republican enterprise

The firm of Small, Boulton, and Watt was incorporated in 1774, as the American Continental Congress was first meeting. War approached, and the climate chilled for republican activities in England. "Treason!" was cried against open friends of the colonies; mob violence and prosecution threatened them. Benjamin Franklin was himself repeatedly insulted and menaced in public gatherings; his Birmingham junto came under minute surveillance.

William Small died suddenly on Feb. 25, 1775, at the age of 41. No one has bothered to assign a cause to his death. Under circumstances of terror, Small's body was thrown into an unmarked grave. Franklin left England forever, a few days later.

Matthew Boulton wrote to James Watt about Small: "The . . . curtain has fallen and I have this evening bid adieu to our once good and virtuous friend for ever and ever. If there were not a few other objects yet remaining for me to settle my affections upon, I should wish also to take up my abode in the mansions of the dead."

After Small's death, the Birmingham group was secretly organized as the Lunar Society; only Priestley would ever speak openly about it, many years later.

Canal partner Josiah Wedgwood was publicly identified with the American cause, though he had to be very cautious. His pottery plant struck two heroic portrait medallions in 1777: the American commander, George Washington, and the Revolution's global coordinator, Benjamin Franklin. After the war, Wedgwood produced medallions depicting a Negro slave with his chains broken, and sent several to Franklin for his use as America's anti-slavery leader.

Matthew Boulton, under close scrutiny, made a proper parade of his loyalty to the Crown. Yet Franklin wrote Boulton from his wartime French headquarters on July 25, 1780, paying for the fine paper Boulton had sent him, and ordering three letter-copying machines invented by James Watt, about which Boulton had informed him.

Franklin's networks made other technological breakthroughs. Clergyman Edmund Cartwright invented the power loom in 1784, and applied Boulton and Watt engines for the first time to textile manufacturing. Cartwright's motive was explicitly that of a republican Christian: Increased productive power would dignify the lives of the workers. Edmund Cartwright later invented a wool-combing machine. His inventions were to be of great manufacturing importance, but he was ousted from productive business by creditors. Edmund's brother, Maj. John Cartwright, founded The Society for Constitutional Information in 1780. Major Cartwright had refused a commission to fight the Americans, declaring that as human rights come from God, they cannot be taken away by any man.

Boulton and Watt toured France in 1787 as guests of the French government. English ironmaster John Wilkinson now taught the French the art of cannon-boring, supplied them with artillery and other vital military equipment, and helped build the Paris waterworks.

By 1791, the British oligarchy had mounted a broad counter-campaign against the republican movement. Their improvised mob terror was devastating France; U.S. President George Washington's administration was barraged with slander against the nationalist chief, Alexander Hamilton. With Britain poised for another war with America's ally, France, the Birmingham junto came under the long-expected attack.

The slogan was, "Down with the French Revolutionists," on July 14, 1791, as an officially sanctioned "rioting mob" sacked and burned Joseph Priestley's Birmingham house and laboratory, and two churches where he preached. Troops led by Lord Shelburne's Scottish lieutenant Henry Dundas then invaded Birmingham to "restore order." King George III said he was sorry for the disturbance, but was glad it had happened to Priestley. The Priestley family was forced to emigrate to America.

After the Birmingham riot, James Watt attended the next Lunar Society meeting wearing a pistol for protection. But the society was crushed, ceased functioning, and soon disbanded. Cartwright's Society for Constitutional Information came under police attack and infiltration. Society member Tom Paine, the Englishman whom Franklin had recruited to the American cause, escaped to France.

The open-ended project for science and industry, which could easily have been extended to develop the entire world in short order, was aborted in England. The enterprises begun in the 1760s and 1770s had created such immense public wealth that they could only be controlled, not cancelled. Britain would not again introduce strategically important technology to the world.

3. The nationalists dump free trade

The success of the American Revolution established the United States as an enclave protected from the imperial fist, a strategic center for the pursuit of mankind's progress. The administration of President George Washington, and Treasury Secretary Alexander Hamilton, boldly asserted that the duty of republican government was to sponsor industry. A Bank of the United States was created, to combat financier wrecking operations and usury.

But the promoters of British free-trade doctrines, the alliance of Southern slave plantation owners (who exported to Britain) and Boston merchants (who imported from Britain), overpowered the Washington-Hamilton program. Hamilton's proposals for protective tariffs and for government construction of canals and other infrastructure were stifled in Congress.

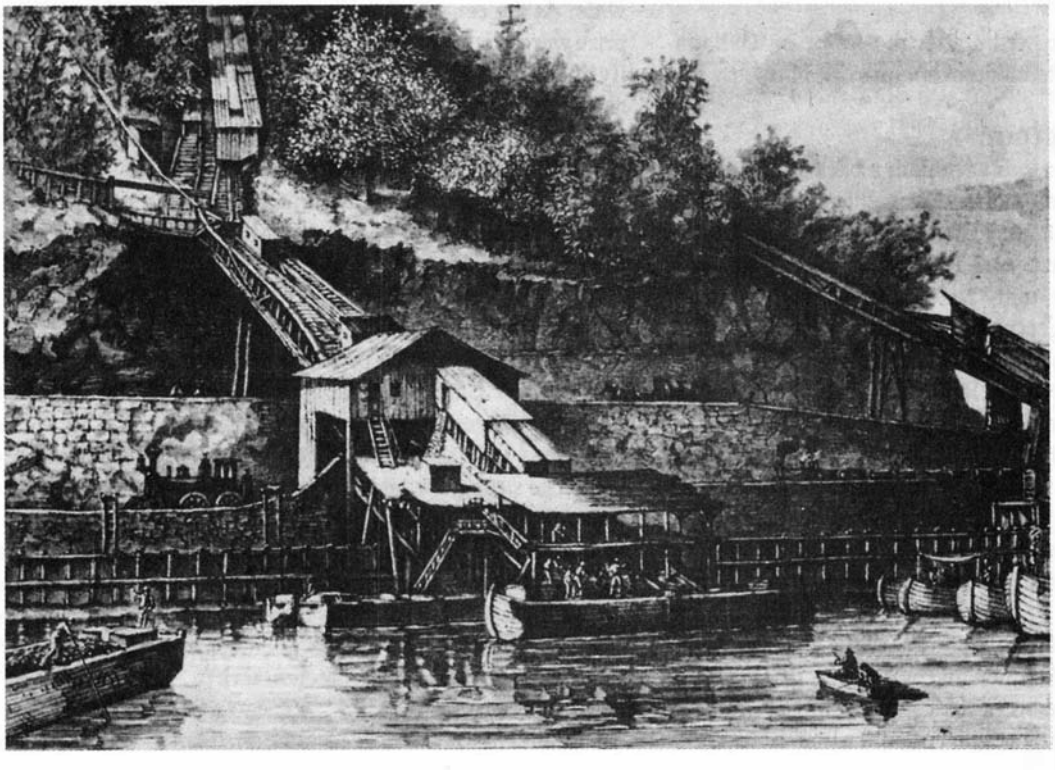
Beside the Bank, certain national institutions were born, and struggled along: A small Navy was supplied with some warships, but Albert Gallatin (treasury secretary in 1802-13) virtually dissolved it, and most of the Army with it.

A U.S. Military Academy was established at West Point, New York. Benjamin Franklin's nephew and former personal secretary, Jonathan Williams, was the tiny Academy's first superintendent. Williams founded a Military Philosophical Society, which lobbied for scientific, technological, and industrial development. Army arsenals, and certain private arms suppliers to the Army, pioneered in the precision design of interchangeable parts in manufacturing.

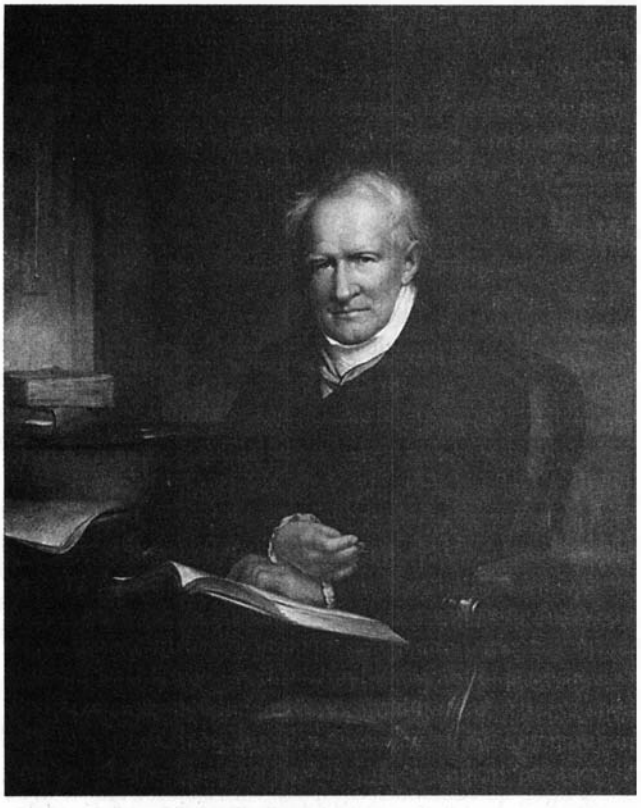
The nation also began to benefit from the steamboat invented by Pennsylvanian Robert Fulton. Franklin had introduced Fulton to his circle in England; Fulton had apprenticed in canal-building with the Duke of Bridgewater, and in steam engineering with the Boulton and Watt firm, which Franklin had guided, to produce the first commercial steam engine (see previous article).

Hamilton gave Fulton a private, lavish grant, enabling Fulton to move to France in 1797 to aid the French in their war against the British Empire. Fulton developed for Gaspard Monge, the Leibnizian geometer who had founded France's great technological institute, the Ecole Polytechnique, the previous year, a fully functional submarine and torpedoes. Fulton said they were designed "to destroy the British fleet," and to help end the "monstrous" British government. But Napoleon Bonaparte scuttled the project.

Fulton's steamboats, equipped with Boulton and Watt engines, made Fulton famous when they began to ply American waters in 1807. Fulton then led a campaign for a great waterway linking New York City to the Great Lakes. Construction on the Erie Canal would finally be started as a state enterprise



Pennsylvania's state-financed transport system delivered cheap coal, to fuel the first phase of U.S. industrialization. Here, anthracite coal is loaded at Mauch Chunk, later called Jim Thorpe, Pennsylvania.



This portrait of German scientist Alexander von Humboldt is on display at the American Philosophical Society in Philadelphia. Humboldt sponsored and coordinated the work of scientists throughout the world, using his diplomatic influence to protect champions of republicanism and scientific progress everywhere.

beginning in 1815, many years after the Jefferson-Gallatin administration had rejected federal sponsorship.

The nationalists regroup

But the United States was to remain a backward, mostly rural country, until a nationalist movement revived Hamilton's policies a generation after the Revolution. Then, in two spectacular jumps, in the period 1824 to the mid-1840s, and from 1861 to about the mid-1880s, the nationalists made America the world's biggest industrial power. From their U.S. base, the nationalists would operate simultaneously in many countries, keeping the enemy British Empire at bay while they brought the world into modern times.

A large portrait of the German scientist Alexander von Humboldt hangs on the wall of the American Philosophical Society in Philadelphia. The painting commemorates Humboldt's 1804 visit to the city, and his indispensable role as foster-father to American science and republican strategy until his death in 1859.

In 1804, Humboldt, the collaborator of the German "poet of freedom" Friedrich Schiller and a devotee of Franklin, reminded the Philadelphians of their fathers' limitless ambitions for their country, and the great esteem which Europeans held for the American cause. From this visit, the intelligence channel between the republican elites of Europe and America was revived and strengthened.

Ten years later, a second war was raging between the United States and Great Britain. British troops burned Washington, D.C., but the Americans fought the Empire to a standstill and forced a peace treaty in 1815.

Secretary of War James Monroe quickly sent Gen. Winfield Scott and Maj. Sylvanus Thayer to tour European military installations. Humboldt aided these U.S. officers in acquiring valuable material and personnel from the Ecole Polytechnique, which was being suppressed and destroyed by the concerted British and Continental European oligarchy ruling France after the fall of Napoleon. Books, maps, charts, and equipment were taken off to America and installed in the Army's officer training school at West Point. In this effort to preserve the Leibnizian scientific tradition, Humboldt at the same time was finding positions for Ecole teachers in the German states. He paid special attention to building up the capability of Göttingen University in Hanover, which Franklin had visited in 1766.

Claudius Crozet was brought from the Ecole to West Point, where he introduced to Americans the study of descriptive geometry, the crucial engineering methodology devised by Ecole founder Monge. West Point now suddenly acquired great significance in American life. The Army officers who were subsequently trained there constituted the nation's only pool of competent engineers.

Following the War of 1812, American nationalists reestablished Philadelphia, the former capital city of the American Revolution, as a headquarters for republican politics worldwide. At the center of the leadership grouping of this enterprise were Mathew Carey (1760-1839), who is known primarily as a publisher, and Nicholas Biddle (1786-1844), famous as the president of the revived Bank of the United States. Their leading collaborators were the German-born economist Friedrich List (1789-1846), who was a Philadelphian for a few crucial years, and the great American statesmen John Quincy Adams (1765-1848) of Massachusetts and Henry Clay (1777-1852) of Kentucky.

The leaders

Let us introduce our protagonists.

Mathew Carey had come to America in 1784, an Irish Catholic refugee from British persecution. He had served as Franklin's leading political agent in the abortive Irish independence struggle, which coincided with the American Revolution (see *EIR,* Dec. 15, 1995, "America and the Irish Revolution," pp. 73-75). After working as a printer for Franklin in Paris, Carey had returned to Ireland to edit and publish the newspapers of the Volunteers movement, linking Protestants and Catholics together behind the Franklin-Carey program for Irish independence, protective tariffs, and industrial development.

When Carey was forced to flee to America, escaping a

British charge of treason, General Washington and the Marquis de Lafayette sponsored his start as a publisher. Carey went on to publish and promote the work of the best American writers, including James Fenimore Cooper, Edgar Allen Poe, and the geographer-theologian Jedidiah Morse, founder of the pro-republican Christian missionary movement.

Carey's widely popular pamphlet *The Olive Branch,* had rallied Americans to the bipartisan task of defense against Britain in the War of 1812. To counter the trade war which followed the peace in 1815, Carey wrote and issued economics pamphlets stressing protective tariffs for the defense of national interests. He challenged the British imperial free-trade economists such as Adam Smith and Thomas Malthus, who were considered "authorities" by Anglophile bankers and colleges under their influence. Carey was first and always a fighter for high wages and help for the poor.

In 1810, Carey, joined only by a few supporters, including **Nicholas Biddle,** led an unsuccessful campaign for the continuance of Hamilton's Bank of the United States, whose charter was due to expire in 1811. Then a Pennsylavania state legislator (and a classical Greek scholar), Biddle told his colleagues that without a U.S. Bank, there would be a credit squeeze and a financial monopoly by "moneyed aristocrats," which would "place the poorer classes at the mercy of the rich, and the great money lenders [would] issue abroad to prey upon their fellow citizens." After the nation was forced to fight the War of 1812 while bankrupt and disarmed, patriots generally followed Carey's lead; Philadelphian Alexander J. Dallas was installed as U.S. treasury secretary in 1814, and the Bank was rechartered in 1816.

Earlier members of Biddle's family had been members of Franklin's philosophical and political training group, the Junto. On an intelligence-gathering tour of Europe, Biddle had served (1807) as private secretary to James Monroe, then the U.S. ambassador to Britain, and had been virtually adopted into Monroe's family. Monroe was elected U.S. President in 1816; Biddle continued to serve him and his secretary of state, John Quincy Adams, as an intelligence adviser, with special responsibility for the growing movement for independence in Latin America. In 1819, President Monroe appointed Biddle to be one of the directors of the reestablished Bank of the United States.

Rep. **Henry Clay** had been the leader of the party demanding war against Britain in 1812. After the Peace of 1815, when Europe lay in the grip of combined feudal monarchies, Clay adopted the economic proposals of Carey as the means of ensuring the continued progress of Western civilization. Clay used the name "The American System," to signify Carey's proposed revival of Hamilton's protective tariffs, sovereign republican national banking, and national infrastructure projects.

John Quincy Adams was secretary of state in 1817-25, the sixth U.S. President in 1825-29, and the leading anti-slavery activist in Congress during 1831-48. He had taken up the study of Plato in 1784, at age 17, while he lived in Paris in the company of the U.S. ambassador, Franklin. Later, Adams wrote that Plato's lesson of the "indissoluble union of moral beauty and goodness . . . made a deep and lasting impression on my mind." John Quincy Adams went to Prussia in 1797 as the first U.S. ambassador there, while his father, John Adams, was President. As America's main European intelligence officer, the young man immersed himself in the new German classics being written by Schiller, Gotthold Lessing, and other republicans. The younger Adams was for a time a Harvard professor—at odds with the fancy Bostonians—and a national leader in promoting German language and literature in America. Adams became an expert historical student of the Grand Design of France's King Henry IV and his minister Sully, for the improvement of the world through sovereign governments acting cooperatively.

Friedrich List would become the leading international economist of the American System, in opposition to the British free trade dogma. List arrived in the United States in 1825, just as the nationalists had achieved political power. He had already spent several years in exile and in prison for his politics in Germany. He had taught political economy in Tübingen University, and was a protégé and political colleague of the Tübingen publisher Johann Friedrich Cotta, who had earlier promoted Schiller. List was the acknowledged leader and theoretician of the German republic movement.

In 1819, List was elected chairman of the new Handelsverein (association of industrialists). He aimed, as had Cotta, to unify the various German principalities under a single government which could industrialize backward Germany; this would make possible an alliance of Russia, Germany, France, and the United States, to break the power of the British Empire. A member of the Württemberg Parliament, List proposed government credits to build industry. The pro-British party and Austria's Prince Metternich procured List's imprisonment, then exile. Lafayette invited List, the honored convict, to accompany him to the United States. Lafayette's 1825 tour, with List, commemorated General Lafayette's role in the American Revolution, and recalled for Americans the Revolutionary ideas which the nationalists would now again pursue in earnest.

Government action directs the first phase

Before the nationalists—Carey, Biddle, Clay, and Adams—came to power in 1823-25, the United States had no railroads, no canals (though the Erie Canal was slowly being built, with primitive methods), an insignificant iron industry, no modern factories to speak of, no industrial steam power, no metal machines operating in production facilities, and virtually no public schools.

President Monroe appointed Biddle president of the Bank of the United States in 1823, replacing Langdon Cheves, a tight-credit man, previously in that post. That same year, Clay became Speaker of the House of Representatives. In 1824, Clay put through the first effective protective tariff law, and the General Survey Act authorizing the use of Army personnel

Nicholas Biddle (1786-1844), president of the Bank of the United States. Biddle and political strategist Mathew Carey allied with John Quincy Adams and Henry Clay to revive the Founders' nationalism. They used public credit, Army engineers, and high tariffs to create America's railroads, canals, iron forges, and factories.

to aid in civil engineering projects.

John Quincy Adams was elected President in 1824, and took office in March 1825. He appointed Clay secretary of state, and Richard Rush as treasury secretary, through whom Biddle's Bank of the United States would work with the Executive branch of government. Rush was a Philadelphian, closely tied by family to Franklin, and to Biddle.

The nationalists were now ready to organize the creation of railroads and canals, and the beginning of the large-scale coal, iron, and machine industries that would define an entirely new economy, virtually overnight.

The wealthiest Americans, the Massachusetts elite merchants, had made their money from participation in Britain's slave trade and opium trafficking, and from importing British manufactures. They looked with scorn on productive industry in general, and they would not risk money building railroads.

Thus, *virtually all U.S. railroad construction was of necessity sponsored by government,* involving cooperation at the federal, state, and local levels.

President John Quincy Adams assigned West Point's Army engineers to plan the route for America's first successful commercial railroad, the Baltimore & Ohio. The enterprise was financed by the city of Baltimore and the state of Maryland, whose stock purchases and loans brought timid private investors in as partners. The resulting railroad line was privately owned and managed by Baltimore merchants who were republican allies of Biddle and Carey.

In all, 61 railroads were designed by U.S. Army engineers, until a free-trade-crazed Congress in 1837 outlawed the use of Army engineers for railroad planning. Meanwhile, states, counties, and cities invested massive sums to connect themselves to the rail grid. **Table 1** shows only some of this nineteenth-century financing, and does not encompass President Abraham Lincoln's revolutionary transcontinental railroad projects (discussed below).

The various state and local authorities arranged to organize and charter private railroad corporations, as well as state-owned canals, and usually issued bonds to subsidize or entirely pay for the enterprises, both private and public alike. These bonds would be marketed under the direction of Biddle's Bank of the United States, and often would involve the allies of Biddle and Carey in state government banks. (British bankers and capitalists who bought these state-issued or state-backed bonds, from time to time provided a certain undetermined minority fraction of the total funds invested in U.S. railroad construction. This fact has been turned into the myth that "the British" or "the Baring Bank" built U.S. railroads.)

List was invited by Carey's Pennsylvania Society for the Promotion of Manufacturing and Mechanical Arts, to prepare a book on economic theory, to attack Adam Smith and the British free trade doctrine. List's 1827 *Outlines of American Political Economy,* published by the Society, prefigured his 1841 *National System of Political Economy.* His work, and that of Mathew Carey's son Henry C. Carey, was to circulate throughout the world as the *standard economics texts outside the British Empire*—until the British succeeded in suppressing this literature in virtually every school in the world, obliterating it from public memory.

In 1827, Mathew Carey and List organized a great protectionist national convention in Pennsylvania. The following year, their movement pushed through the U.S. Congress a higher tariff schedule, branded the "Tariff of Abominations" by free-trade advocates ever since. This 1828 tariff became the focus of attack against the whole nationalist program, with the new threat that southern slaveholding states would secede from the Union unless the tariff were lowered.

The effects of the nationalist tariffs can be read most clearly in the record of the U.S. iron industry (see **Table 2**). No regular statistics were kept for U.S. iron or steel output until 1820, because American production of these metals was only carried on in tiny, primitive local forges. In 1820, the U.S. manufacture of pig iron (metal output from smelting iron ore) was 20,000 tons, about what it had been in the eighteenth-century colonial days.

TABLE 1

Railroad construction financed by state and local governments

(selected examples, 19th century)

State	Corporation or jurisdiction	Years	Amount and type of government aid*
Alabama	Ala. & Tenn. River RR	1850	$100,000+; purchase corp. stock
		1850s	Federal land grant for RR construction
Arkansas	7 railroads	1868-1879	$5,350,000 state bonds
			Citizens could invest in RR in lieu of tax payments.
Connecticut	Cities/counties	as of 1883	$5,106,000 RR debt=ca. 3/4 of the debt of the localities.
Delaware	5 railroads	1837-	$961,000 state loans to corps.
	New Castle & Frenchtown	1852	$180,000 purchase corp. stock
Florida	railroad companies	Begin 1835	Grant right-of-way, construction materials, land for stations
Georgia	Monroe railroad	1842	$200,000 stock purchase
	Atlantic & Gulf RR	1867	$1,000,000 stock purchase
Illinois	Illinois Central RR	1850s	Federal land grant for RR construction
	86 counties	Early years	$16,088,027 total state subsidies
Iowa	Towns and counties	as of 1856	$7,000,000 railroad bonds issued
Indiana	2 railroads	Early years	$687,000 state bonds issued
Kentucky	Lexington & Ohio RR	1833	$150,000 guarantee corp. bonds
	Lexington & Ohio RR		$200,000 purchase corp. stock
	localities	As of 1871	$13,783,983 local govt. RR debt
Louisiana	New Orleans	as of 1853	$3,500,000 city RR debt
	2 railroads	before 1861	$1,483,000 purchase corp. stock
	4 railroads	1865-1879	$3,842,000 purchase corp. stock
Maryland	Baltimore & Ohio RR	1828-1836	$11,700,000 purchase corp. stock
	Baltimore city govt.	1828-1853	$7,830,000 city RR debt
	Baltimore & Susquehanna RR		$1,879,000 state loan
Massachusetts	towns	as of 1871	$2,351,000 railroad debt
	European & No. Amer. RR	Early years	$678,362 state subsidy
	Western RR	1836	$1,000,000 purchase corp. stock
	Various railroads	1837-1870	$11,290,000 state loans
Michigan	4 railroads	1837-1938	$240,000 state loans
Minnesota	48 railroads	1869-1905	$2,949,150 towns issued bonds
	4 railroads	1858	$2,275,000 state loans
Mississippi	New Orleans, Ja & GN RR	1854	1/3 of Internal Improvement Fund
	NewOr, Ja & GN RR	1857	1/3 of Chicasaw school fund
		1850s	Federal land grant for RR construction
Missouri	7 railroads	as of 1853	$8,124,075 city/county RR stock
	Missouri Pacific, etc.	1850s laws	$19,201,000 state bonds loaned
Nebraska	43 counties	Early years	$4,918,000 railroad subsidy bonds
New York	294 cities and towns	Early years	$29,978,206 subsidies to RR construction
	51 counties	Early years	subsidies $5,000-$3,000,000/county
	N.Y. & Erie, 8 others	Early years	$8,206,591 state loans
North Carolina	Wilmington & Ral RR	1836	$500,000 purchase corp. stock
	Atlantic & N.C. RR	1854	$1,200,000 (2/3 of the stock)
	Western N.C. RR	before 1873	$4,000,000 (2/3 of the stock)
	Cape Fear & Yadkin		Entirely built by convicts
	North Carolina RR	before 1873	$3,000,000 (3/4 of the stock)
	2 railroads	before 1883	state purchase corp. stock
	4 railroads	1838-1840	state guarantee corp. debts
Ohio	several railroads	before 1837	Various specific RR subsidies
	6 railroads	1837 law	$717,515 state purchase stock
Pennsylvania	Pittsburgh	as of 1853	$3,450,000 city railroad debt
	Philadelphia	as of 1853	$8,154,000 city railroad debt
	3 railroads	late 1830s	$420,000 Bank of U.S. investment
South Carolina	Louvlle Cin & Charleston	ca. 1837	$800,000 purchase corp. stock
	6 other railroads	1848-1868	$1,675,000 purchase corp. stock
	8 railroads	begin 1837	$10,000,000 guarantee corp. bonds
Tennessee	Memphis/Ltl Rock RR	before 1852	$350,000 Memphis purchased stock
	2 railroads	before 1852	$851,000 state purchase stock
	various railroads	before 1852	$2,196,000 state guarantee bonds
	various railroads	Act of 1852	$28,351,000 state loans for RR construction at $8-10,000 per mile

TABLE 1

Railroad construction financed by state and local governments *continued*

(selected examples, 19th century)

State	Corporation or jurisdiction	Years	Amount and type of government aid*
Virginia	counties	Early years	$10,000,000+ total county RR debts
	Chesapeake & Ohio	before 1861	$5,000,000 state purchase stock
	Chesapeake & Ohio	before 1861	$1,750,000 direct state construction
	various other RRs	before 1861	$16,000,000 state purchase stock**
	4 railroads	before 1861	$730,000 loans & guarantees
West Virginia	Wheeling	as of 1853	$1,100,000 city RR debt
Wisconsin	counties	as of 1874	$8,522,224 county RR investment

* Subsidies, loans, and guarantees listed here total about $300 million. ** State policy was to buy 3/5 of the stock of any railroad built in Virginia.

Government—state, local, and federal—financed the construction of the U.S. railroads. Consider the early role of state governments. As of 1838, the individual states of the Union carried a total of $60,202,000 in canal debts, $42,871,000 in railroad debts, and $6,619,000 in highway debts, for a grand total of $109,692,000 in state transportation debts. This was 63.7% of the $172,306,000 total debts of all the states at that time. [Source: Dorothy R. Adler, British Investment in American Railways, 1834-1898 *(Charlottesville: University Press of Virginia, 1970).]*

The 1838 state railroad debt of $42,871,000 represented $22,410 per mile for the 1,913 miles of railroad already built. But what proportion *of the cost of the railroads did this* state *commitment represent? Did railroads cost $25,000 per mile, or $125,000?*

The U.S. Commerce Department's Historical Statistics of the United States *tells us that 12 years later, by 1850, the* total *direct investment in American railroads was $318,126,000, or $35,265 for each of the 9,021 miles built by 1850.*

Thus the $22,410/mile figure for state railroad debt as of 1838 suggests that the states arranged for a large proportion of the funds to build the early railroads.

Neither county nor city railroad debts are considered here, nor the various government stock purchases or other subsidies, nor state or federal land grants, nor military engineering.

There was some advance in iron production in 1821-23, with the mildly protective tariff of 1821. But the 1824, 1828, and 1842 tariff laws sharply increased protection against British-imported iron, and U. S. manufacturers immediately organized new production facilities in response to these changes in the law. As soon as the tariffs were lowered, in 1833 and again in 1847, new enterprises stopped being set up, and existing businesses contracted or folded.

Pig iron production rose from 61,250 tons in 1823, to 130,000 tons in 1828, to 200,000 tons in 1832. After the tariff was lowered, pig iron output rose and fell erratically, and was only 230,000 tons in 1842, when Clay was able to put through a sharply higher tariff. Iron output rose immediately, reaching 800,000 tons in 1847. Then, the Boston merchants and slave owners free-trade alliance reduced the tariff again, and U. S. annual iron production stagnated at an average of less than 800,000 tons until the Civil War of 1861-65.

Building an iron industry and railroads, the nationalists directed a radical shift in the national industrial base and a huge increase in energy throughput.

England had converted from primitive human- and animal-powered production, to artificially powered machine industry, by the projects of the Birmingham group: canals, coal, and steam engines. Fulton published a lavishly illustrated treatise in London in 1796, dedicated to President Washington, proposing the industrialization of America along similar lines, and specifying Pennsylvania canals as the core strategy.

The Philadelphia group used the approaching completion of New York's Erie Canal as a public explanation for their dramatic proposal: in order to save their state's trade to the Great Lakes and the Middle West, in competition with New York, Pennsylvania must build canals on a grand scale. The Pennsylvania Society for the Promotion of Internal Improvements (Nicholas Biddle, secretary) won funding from the legislature for a $13 million system of canals entirely within the state, the largest public works project yet undertaken anywhere, with a total mileage twice that of the Erie Canal.

Biddle's friends also built privately owned navigation projects. Ebenezer Hazard, a political operative of both Mathew Carey and Hamilton, financed the canalization of the Lehigh River for his son Erskine Hazard and Josiah White. Philip Hone, a political lieutenant to Clay and Biddle who was elected mayor of New York in 1825, built the Delaware and Hudson Canal, from northeast Pennsylvania into New York City; this was financed by the State of New York, and by Hone's merchant friends.

Coal-based industry

These canal projects, public and private, were backed to the hilt by Biddle's Bank of the United States. But their objective was to industrialize America with coal.

Eastern Pennsylvania is rich in hard anthracite coal,

TABLE 2

U.S. policy shifts, showing tariff rates and iron production

(Figures shown for every third year, 1791-1908)

Year	Tariff rate (%)	Iron production (000 tons)	Policy shifts
1789-1800			Nationalists, President Washington and Treasury Secretary Hamilton, but free-trade Congress
1791	22.94		
1794	24.82		
1797	17.07		
1800	17.54		
1803	22.06		Free-traders President Jefferson, Treasury Secretary Gallatin
1806	19.18		
1809	18.26		
1812	18.66		
1815	33.66		War of 1812
1816			Bank of U.S. re-chartered; Ecole Polytechnique teachers and methods transferred to West Point
1818	21.24		
1819			Mathew Carey begins protectionist tariff agitation
1821	35.97*	34	
1823			Biddle appointed president of Bank of the U.S.
1824	37.53	75	House Speaker Henry Clay's iron-protective tariff
1825			President John Q. Adams begins Army-engineered railroads
1827	41.35	116	Carey-List tariff agitation, canal-coal projects
1830	48.88	165	
1832			So. Carolina secession threat forces tariff reduction
1833	31.96	214	
1836	31.65	258	
1839	29.90	301	
1842	24.00	230	
1843			Beginning of Henry Clay's higher tariff
1845	32.57	631	
1847			Beginning of free-trade faction's reduced tariff
1848	24.97	800	
1851	25.44	532	
1854	25.61	833	
1857	22.45	798	
1860	19.67	884	
1861-65			Lincoln regime, free-trade/slavery bloc dissolves
1863	32.62	947	Iron-steel tariffs at around 50%
1866	48.33	1,206	
1869	47.25	1,711	Iron-steel tariffs at around 90%
1869-72		"	Philadelphia Interests" in vast steel and RR projects
1872	41.35	2,548	
1873			British bankers destroy Jay Cooke, crash U.S. economy
1875	40.62	2,023	
1878	42.75	2,301	"Philadelphia Interests" launch Edison power/light project
1881	43.27	4,144	Nationalist Garfield inaugurated, shot in 4 months
1884	41.61	4,097	
1887	47.08	6,417	
1890	44.39	9,202	Congressman McKinley's protectionist Tariff of 1890
1893	49.46	7,124	Free-trade Grover Cleveland regime begins
1896	39.95	8,623	
1897			McKinley regime raises tariffs
1899	52.07	13,621	
1901			McKinley shot, Teddy Roosevelt strikes at nationalism
1902	49.79	17,821	
1905	45.24	22,992	
1908	42.94	15,936	

* Tariff rates shown before 1821 are average *ad valorem* rates on free and dutiable imports; 1821 and after, rates on dutiable imports only

Sources: Tariff rates and iron production from Fred J. Guetter and Albert McKinley, *Statistical Tables Relating to the Economic Growth of the United States* (Philadelphia: McKinley Publishing Co., 1924).

which burns with great heat and no soot. Anthracite was not in general use before the War of 1812, while the soft, bituminous coal found further west and south was used only in some locations, largely for home heating. Pittsburgh, a Philadelphia colony with immense mineral resources, had its own tiny, local coal-driven industrial economy. Boston and New York imported coal from England, for their fashionable hearth fires.

The Philadelphia nationalists, through such instruments as Hazard and White's Lehigh Coal and Navigation Company, bought up coal-bearing properties in the counties north of Philadelphia. Prof. Friedrich List was one of the leading mine operators, and a pioneer in coal transport technology.

While opening mines and digging canals, the group had to educate the community on the virtues of the new fuel. Public opinion had decided that anthracite was unusable. Blacksmiths had seen it *extinguish* their fires. A wide campaign of demonstrations and advertising, and plunging prices because of cheap canal transport, finally satisfied everyone that anthracite just had a higher ignition temperature, along with its higher energy content. Coal barges crowded the new canals, and a special fleet of Philadelphia steamers carried anthracite to all the cities of the Atlantic coast.

Anthracite production for the market rose from zero in 1819, to 8,000 tons per year in 1823, to 1 million tons in 1837. Production remained in that general range until the

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.

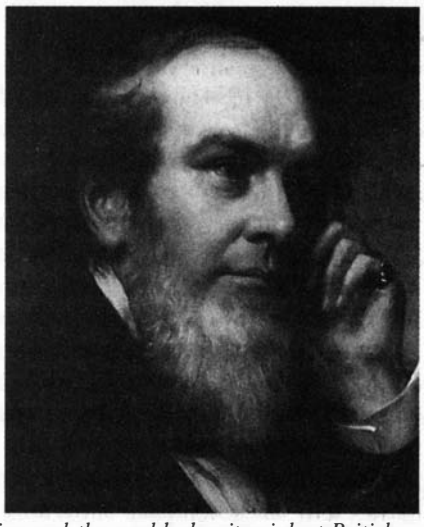
Several years later, Melnikov and Crown Prince Alexander II headed a committee to begin this development. The Russians hired a retired U.S. Army officer, George Washington Whistler, one of the original West Point engineers who had been assigned by President John Quincy Adams to design the first American 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 Göt-

tingen 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:

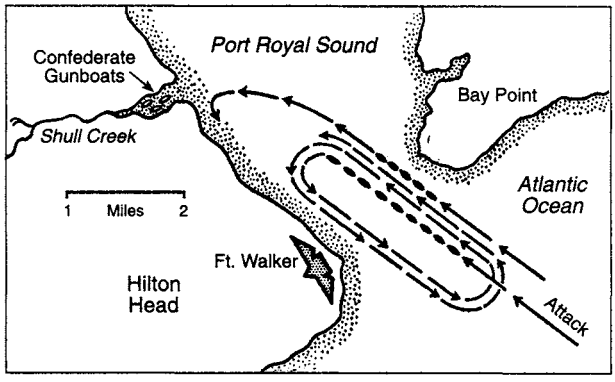
"The low wages of operatives generally in Europe, low relatively to the prices of conveniences, tends to keep the mass of them from intellectual improvement. Their youth is passed before they can judge of the necessity for culture, and [later adult responsibilities] . . . press on them so heavily, that 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,

canal, and railway construction, he put the brakes on pioneer settlement of the West. But American nationalists, mostly members of Henry Clay's Whig Party, fought to continue the "internal improvements" construction policy, with the action of state governments to replace the missing federal support.

State legislator Abraham Lincoln, then 27, led this fight in Illinois. He sought to turn the mud- and ice-bound Midwest into the new industrial center of the continent, beginning with the construction of 2,000 miles of railways and canals to criss-cross Illinois. Here is what his first important biographers, John G. Nicolay and John M. Hay, report:

"If Mr. Lincoln had no other claims to be remembered than his services in the Legislature of 1836-7, there would be little to say in his favor. Its history is one of disaster to the State. Its legislation was almost wholly unwise and hurtful. . . . In the account of errors and follies committed by the Legislature . . . he is entitled to no praise or blame beyond the rest. He shared in that sanguine epidemic of financial and industrial quackery which devastated the entire community, and voted with the best men of the country in favor of schemes which appeared then like a promise of an immediate millennium, and now seem like midsummer madness.

"He entered political life in one of those eras of delusive prosperity which so often precede great financial convulsions. . . . It was too much to expect of the Illinois Legislature that it should understand that the best thing it could do to forward this prosperous tendency of things was to do nothing."

"Madness"? "Delusive prosperity"? In fact, as the *Encyclopedia Britannica* puts it, "The growth of manufacturing in Illinois, largely because of the development of the state's exceptional transportation facilities, was the most rapid and remarkable in the industrial history of the United States. In 1850 the state ranked 15th; in 1870, 6th."

Yet virtually all historians, and Lincoln biographers, reiterate the Nicolay and Hay vituperation of Illinois' "internal improvement follies" of 1836-37. Since Nicolay and Hay were secretary and assistant secretary to Lincoln during his Presidency, their 10-volume biography was given almost unlimited credence.

Abraham Lincoln was the sprited young leader of the "Long Nine" (all over six feet tall), Sangamon County's representatives who went to the Illinois Legislature in December 1836. Lincoln's forces pushed through plans for the state to build a series of rail lines and canals, taking a leadership that marked his first important political role. Twelve million dollars was appropriated, $3.5 million for the state-chartered Illinois Central line to be built from Galena in the north, to Cairo in the south. The state would borrow money on U.S. and European capital markets, taking advantage of the great excitement internationally over America's development prospects, the success of the Erie Canal and the giant Pennsylavnia program.

Lincoln also took the lead in defending and trying to expand the capital of the state bank of Illinois, hoping that, for Illinois' purposes, it could stand in for the moribund Bank of the United States.

Construction began with the Northern Cross Railroad, projected to be built from Quincy on the Mississippi River eastward across Illinois to the Indiana line. The first locomotive to be put in operation in the Mississippi Valley was delivered from Paterson, New Jersey by riverboat in November 1838. The line was in operation from the Illinois River to the new state capital of Springfield by May 1842.

British tighten the credit screws

But British-centered opposition to this American development proved too strong. The Bank of England withdrawal of credit from all American enterprises, following President Jackson's closing of the U.S. Bank, resulted in a terrifying credit squeeze.

In the spring of 1837, the British concentrated their attack on New Orleans. Agents in New Orleans were ordered to stop all purchases for British merchants and manufacturers. With American credit now draining away to England, there were no U.S. buyers to replace the British. New Orleans banks were forced to deny credit to merchants, factors, and banks serving the entire Mississippi Valley.

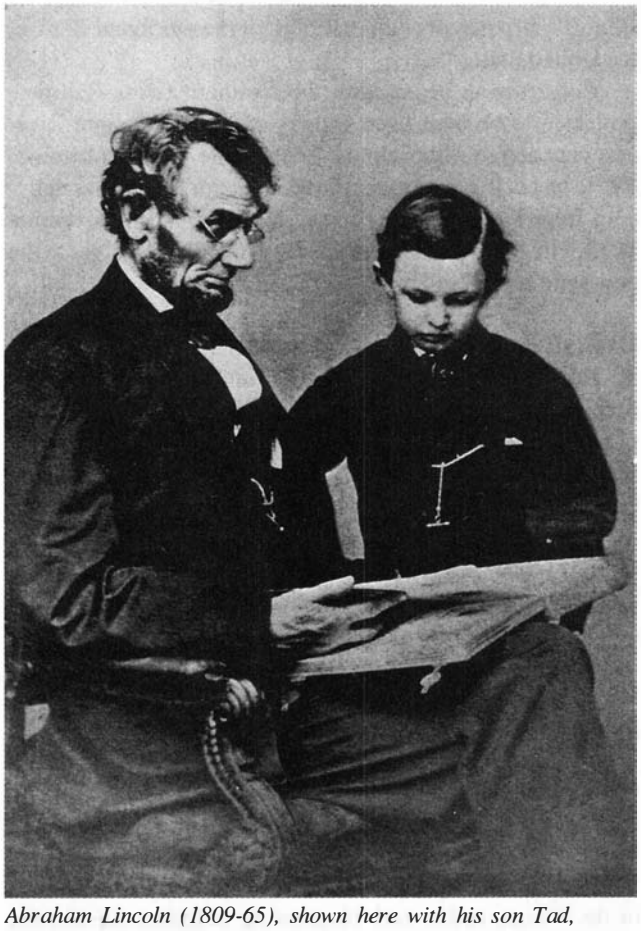
The Illinois railroad building project failed for want of credit, though the Illinois-Michigan Canal, connecting Lake Michigan with the Mississippi River system, was completed by the state government in 1848.

In 1850, the U.S. government, temporarily in the hands of the Whigs, authorized the granting of federal land to the state of Illinois for the construction of a north-south railroad with a Chicago spur: Three square miles of land were to be granted for each mile of railway constructed. In February 1851, the state legislature, frightened by the earlier collapse of its plans for state-owned enterprise, chartered the Illinois Central Railroad Company. The state gave the federal land grant as inducement to Eastern private investors to buy into the construction. Lincoln reluctantly supported this scheme as unavoidable, given the lack of national sovereignty over credit issuance. But we notice, that private capital was never expected to be able to *initiate* a significant railroad construction in America without the sponsorship and subsidy of the government.

The rail network which Lincoln had planned and championed was now quickly built, and eventually made Chicago the rail center of the continent.

John Hay: 'a thousand ties to Britain'

Turning back again to the attack on Lincoln's legislative "follies" by his supposedly friendly biographers: John Hay wrote the first volume of the Nicolay-Hay biography, on Lincoln's first 50 years, and he steered and edited the other nine volumes, covering Lincoln's remaining six years. But his motives may come out more clearly in his 1883 novel, *The Bread-Winners,* where Hay attacked the working people of America,



Abraham Lincoln (1809-65), shown here with his son Tad, revolutionized the U.S. economy at the same time as he led the Union to victory in the Civil War. Lincoln's "statist" measures built the great railroads and heavy industries that made the country a superpower.

and "the restless haste and hunger to rise which is the source of much that is good and most that is evil in American life."

Lincoln's opposite worldview was expressed to a German group in Cincinnati in 1861: "I hold the value of life is to improve one's condition. Whatever is calculated to advance the condition of the honest, struggling laboring man . . . I am for that thing."

Hay later became famous as an atrociously Anglophile diplomat and secretary of state. Hay expressed his own sense of identity in 1898, as U.S. ambassador to Great Britain: "Knitted as we are to the people of Great Britain by a thousand ties . . . there is a sanction like that of religion which binds us to a sort of partnership in the beneficent work of the world. . . . No man and no group of men can prevent it. . . . We are bound by a tie which we did not forge and which we cannot break."

His "definitive" biography of Lincoln, published in 1886, does not even mention Lincoln's role in building the Pacific railway, next to nothing on his economic measures, and not a hint of the lifetime of dirigist philosophy behind them.

Moving mountains

In August 1859, a year before Lincoln was elected to the Presidency, he visited Council Bluffs, Iowa, meeting privately there with a young railroad engineer/surveyor named Granville Dodge, who, as Lincoln's Army officer, was to be the chief engineer of the Pacific railroad.

As Dodge wrote later, Lincoln asked "what I knew of the country west of the Missouri River. He greatly impressed me by the marked interest he displayed in the work in which I was engaged, and he expressed himself as believing that there was nothing more important before the nation at that time than the building of a railroad to the Pacific Coast. He ingeniously extracted a great deal of information from me about the country beyond the river, the climate, the character of the soil, the resources, the rivers and the route. When the long conversation was ended, I realized that most of the things that I had been holding as secrets for my employers in the East, had been given to him without reserve. . . ."

Dodge continued that there was "a high bluff known as Cemetery Hill, just north of town. . . . He was greatly impressed with the outlook; and the bluff from that time has been known as Lincoln's Hill. . . . From here he looked down upon the place, where by his order, four years later, the terminus of the first trans-continental railway was established."

Lincoln signed the Pacific Railway Act July 1, 1862, authorizing huge government land grants to finance the construction. Two years later a second bill doubled the land grants and sweetened the other terms. Altogether *45 million acres of land were given away, and the government laid out some $60 million in cash, compared to only $4 million invested from private capital.*

Lincon was determined to "conquer space" to the west. At one point, when the project seemed dead for lack of funds, he arbitrarily redefined the Rocky Mountains as starting in their foothills, so that more money could be paid to the builders under the legislated formula—$32,000 in the mountains, as against only $16,000 per mile in the flatter land. It was said at the time, "Abraham's faith moves mountains."

6. How Lincoln made farmers scientific

The power of the Union's arms abolished black chattel slavery, the legal remnant of the British imperial past. But America still had to construct a positive alternative to the colonial plantation system. Abraham Lincoln's abiding passion for the protection and productivity of labor, shows up boldly in his Presidential action to bring scientific thinking into agriculture. To modernize America's farms, Lincoln's administration organized a national teaching apparatus run

largely by students of the pioneering German chemist Justus von Liebig. We will consider, below, Liebig's resolute Christian humanism and his contribution to America.

British imperial apologists Thomas Malthus and David Ricardo posited fictitious "natural resources," whose depletion by agriculture must deprive land of its natural, original value, making poverty and hunger inevitable. Colonial or other production-depressing regimes are beneficial, by this doctrine, since they delay the depletion of nature. Environmentalism is just a twentieth-century variant on this old theme.

But a nation mobilized in a war for freedom could not tolerate the blasphemous notion that God's laws consign man to perpetual scarcity and backwardness. Under Lincoln's leadership, Americans created a system to render farming so successful, so powerful and productive, that the lie of inevitable poverty was forever dispelled.

Millions of new private farms were created, by government land grants to households, and to railroads, which obtained credit by selling their grant-lands to new farmers. Farm families were educated at government expense. Government scientists supplied them with the latest intelligence on fertilizers, soil chemistry, and crop management. New farmlands opened up by government-organized railroads allowed for production economies of scale. Farmers with cheap, government-supplied credit, bought machinery, produced by patent-protected inventors using tariff-protected American steel. Diseases of livestock were conquered and eliminated by the vigorous prosecution of government science and federal law.

Lincoln's advocacy of human advancement would put him beyond the pale in today's politics. A visit to Niagara Falls set off reflections which led to his patenting an "improved method of lifting vessel[s] over Shoals," while a fellow visitor to the falls complained of Lincoln's alleged lack of a sense of wonder.

Neither did he romanticize or otherwise propitiate farmers; no farmer asked him beforehand to create the Agriculture Department or America's farm-centered state college systems.

Addressing the Wisconsin State Agricultural Society at its annual fair in Milwaukee on Sept. 30, 1859, Lincoln reprised the argument laid down by Gottfried Leibniz in his "Academy Proposal," on the motivation for work, and the increase of productivity by the elevation of the worker's mind: He began, "I presume I am not expected to [engage] . . . in the mere flattery of the farmers, as a class. My opinion of them is that, in proportion to numbers, they are neither better nor worse than any other people."

Lincoln praised the fair, rather than the farmers, for "exciting emulation, for premiums, and for the pride and honor of success . . . to stimulate . . . discovery and invention into extraordinary activity. In this, these Fairs are kindred to the patent clause in the Constitution of the United States; and to the . . . practical system, based upon that clause."

He warned that current agricultural practices were producing the very low grain yields, 8-18 bushels per acre, compared to the possibility for 50 to 100 bushels, from merely applying available methods. "What would be the effect upon the farming interest," he asked, "to push the soil up to something near its full capacity? . . . Unquestionably, thorough cultivation will require more labor to the *acre;* but will it require more to the *bushel?* . . . It would [uncover] those unknown causes, which of late years have cut down our crops below their former average . . . in the deeper plowing, analysis of the soils, experiments with manures, and varieties of seeds. . . . [T]horough cultivation would spare [at least] half the cost of land, simply because the same product would be got from half, or from less than half the quantity of land. . . .

"Again, a great amount of 'locomotion' is spared by thorough cultivation. Take fifty bushels of wheat . . . [on] a *single* acre, and it can be harvested . . . with less than half the labor which would be required if it were spread over *five* acres. This would be true, if cut by the old hand sicle; true, to a greater extent, if by the scythe and cradle; and to a still greater, if by the machines now in use . . . [which] substitut[e] animal power for the power of men. . . .

"The effect of thorough cultivation upon the farmer's own mind, and, in reaction through his mind, back upon his business, is perhaps quite equal to any other of its effects. Every man is proud of what he does well . . . his heart is in his work; and he will do twice as much of it with less fatigue. . . . The man who produces a good full crop will scarcely ever let any part of it go to waste. He will keep up the enclosure about it, and allow neither man nor beast to trespass upon it. He will gather it in due season and store it in perfect security. . . .

"The successful application of steam power to farm work, is a desideratum—especially a steam plow. . . . To be successful, it must . . . plow better than can be done with animal power . . . and cheaper; or more rapidly." Lincoln proposed the necessity of self-propelled farm machinery, before any such had been invented. But, he then pointed out, accurately, that steam-power was impracticable for this purpose, despite the success of the railroad and steamship, because of the weight of fuel and water a steam vehicle must carry over farmland. This problem was solved a generation later by the use of gasoline engines.

Lincoln then proposed the family farm as one of the means for upholding the freedom and dignity of labor; he went on to describe the problem-solving mentality of the scientific farmer, so different from the ignorant peasant:

Free labor, he wrote, "insists on universal education.

". . . I know nothing so pleasant to the mind, as the discovery of anything that is at once new and valuable—nothing that so lightens and sweetens toil, as the hopeful pursuit of such discovery. [For the] mind, already trained to thought in the country school, or higher school . . . [every] blade of grass is a study; and to produce two, where there was but one, is both a profit and a pleasure. And not grass alone: but soils, seed, and seasons—hedges, ditches, and fences, draining,

droughts, and irrigation . . . saving crops, pests of crops, diseases of crops, and what will prevent or cure them . . . the thousand things of which these are specimens—each a world of study within itself. . . .

"Population must increase rapidly—more rapidly than in former times—and ere long the most valuable of all arts, will be the art of deriving a comfortable subsistance from the smallest area of soil. No community whose every member possesses this art, can ever be the victim of oppression in any of its forms. Such community will be alike independent of crowned-kings, money-kings, and land-kings. . . .

"It is said an Eastern monarch once charged his wise men to invent him a sentence . . . which should be true and appropriate in all times and situations. They presented him the words, 'And this, too, shall pass away.'. . . And yet, let us hope it is not quite true. Let us hope, rather, that by the best cultivation of the physical world, beneath and around us, and the intellectual and moral world within us, we shall secure an individual, social and political prosperity and happiness, whose course shall be onward and upward, and which, while the earth endures, shall not pass away."

Lincoln and continental European science

The natural science, which was to revolutionize agriculture, was itself the work of opponents of colonial Malthusian doctrines. This is perhaps best exemplified by the successes of Justus von Liebig (1803-73), a chemist who grew up in Beethoven's Germany. Liebig's work would be brilliantly realized in Lincoln's agricultural program.

Liebig identified the mineral nutrients required for the growth of plants; he created the analytical and educational methods that made modern biochemistry and such things as artificial fertilizer possible. Liebig described his own early development as "the reading of books without any system . . . just as they stood on the shelves" of the library, and "thousands of essays and treatises." This "developed in me the faculty . . . of thinking in terms of phenomena. . . . Most closely akin is the peculiar power of the musician, who while composing thinks in tones which are as much connected by laws as the logically arranged conceptions in a conclusion or series of conclusions. There is in the chemist a form of thought by which all ideas become visible to the mind as the strains of an imagined piece of music."

At age 17, he went to Paris, and exhibited his talents under the tutelage of Joseph Louis Gay-Lussac and Alexander von Humboldt. By 1820 the French Ecole Polytechnique, whose educators had virtually founded America's early engineering and military science, was already more or less destroyed. So Humboldt used his influence to set up Liebig in his own chair of chemistry at a small German college, at Giessen, in May 1824.

Here organic chemistry was born; and for the first time, teaching took place in a chemical laboratory.

As Liebig described it, "a kindly fate brought together the most talented young men from all the countries of Europe [and America!]. . . . Actual teaching in the laboratory . . . was only for the beginners; the progress of my special students depended on themselves. I gave the task and supervised the carrying out of it. . . . I received from each individual [a daily report about what] he was engaged upon. I approved or made many criticisms . . . by each participating in the work of all, every one learned from the others. . . . We worked from break of day till nightfall. . . . The only complaint . . . was that of the attendant . . . who could not get the workers out of the laboratory in the evening, when he wanted to clean it." Liebig's fame grew as his published works brought before the world the new agricultural and pharmaceutical sciences he and his colleagues were inventing.

Liebig wrote of "the present conflict between practical agriculture and scientific Chemistry." It "concerns the weightiest material interests and the fundamental prosperity of the state. The most urgent problem which the present day has to solve, is the discovery of the means of producing more bread and meat on a given surface, to supply the wants of a continually increasing population," a problem "which science is expected to solve."

Liebig attacks the empiricist, who, with only practical experience and no understanding of the underlying laws of nature, must fail. At the heart of Liebig's worldview is the unique dignity of man, whose creativity is potentially limitless. Man at first "sees everything around him bound in the chains of invariable, immutable, fixed laws. Within himself alone he recognizes a *something* which may govern these effects, a will which has the power to rule over all natural laws, a spirit which, in its manifestations, is independent of these natural powers, and which, when it is in its conceivable perfection, is subject only to its own laws.

"The . . . knowledge of nature forces upon us . . . the conviction that [beyond] this *something* within us . . . there exists [something] similar or more perfect [which] affirms the existence of a higher, indeed of an infinitely exalted Being, to contemplate and to comprehend whom our senses are too feeble, and of whom, in his greatness and sublimity, we can only form some conception by the highest cultivation of every faculty of our minds."

The Agriculture Department is born

On May 15, 1862, President Lincoln signed into law a bill creating the Department of Agriculture, "to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture . . . to procure, propagate and distribute . . . new and valuable seeds and plants . . . to acquire . . . all information . . . by means of books and correspondence and by practical and scientific experiments . . . employees [to include] chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to Agriculture."

The first scientist appointed by the department was Justus von Liebig's student, Charles M. Wetherill.

On May 20, Lincoln signed into law the Homestead Act, giving to any head of a family or to anyone 21 years of age, one-quarter square mile of free land for farming. For the remainder of the century, the act transferred millions of acres of the public domain to private ownership. With the first Lincoln-organized Pacific Railroad completed in 1869, settlers poured into newly opened western lands. Between 1870 and 1880, some 128 million acres were added to U.S. farmland, 49 million acres between the Mississippi River and the Rocky Mountains. The total amount of improved farmland increased 50%, from 189 million to 285 million acres.

On July 2, 1862, Lincoln signed the Land Grant College Act. The same legislation had been vetoed by "free enterprise" radical President James Buchanan, Lincoln's immediate predecessor. The act donated federal land which the states would sell, establishing a perpetual endowment for public colleges in each state. The curriculum, besides military tactics, and "other scientific and classical studies," was to "promote the liberal and practical education of the industrial classes," in areas relating to agriculture and the mechanical arts.

The Land Grant schools, such as Iowa State, Ohio State, and Pennsylvania State colleges, and the older universities which shared in the federal largesse, such as Yale and Harvard, became in the late nineteenth century the potent center of agriculture-related research.

Evan Pugh, the founder of Pennsylvania State College, was a student of Liebig. Another Liebig student, Eben Horsford, returned to America to open a pioneering laboratory at Harvard for teaching analytical chemistry. Horsford's innovations spanned the field from condensed milk to fermentation of bread and alcohol. Horsford's successor at Harvard's Lawrence Scientific School was Prof. Oliver Wolcott Gibbs, another Liebig pupil, and a member of Alexander Dallas Bache's "Lazzaroni" inner circle.

Liebig student John A. Porter, the first dean of the Sheffield Scientific School of Yale, helped develop its courses in agriculture and nutrition. Another pupil of Liebig, William H. Brewer, was professor of agriculture in the Sheffield Scientific School from 1864 to 1903.

Brewer's colleague, S.W. Johnson, returned from Europe and his studies with Liebig in 1856. He then began teaching at Sheffield and translating the latest European works on chemical analysis for American chemists. In 1869, with Johnson's urging, Connecticut passed its Fertilizer Law requiring accurate labeling of contents, to be determined by state chemists. This was soon copied by the other states, realizing in America Liebig's proposal for such government regulation of a field that had been entirely unknown to the previous generation. In 1877, Johnson became director of the new Connecticut Experimental Station, emulating the 100 such stations which Liebig's influence had already established in Germany, Italy, and Austria. With Johnson's lobbying, the U.S. Congress passed the Hatch Act in 1887, creating a national network of experimental stations.

A rich harvest

For about 35 years after the end of the Civil War in 1865, government-sponsored science and government-protected industry guided an immense increase in American agricultural productivity.

After World War II's immense economic mobilization, America used the agricultural institutions founded by Lincoln to take another leap ahead in farm productivity. Science in fertilization, breeding, soil analysis, and heavy mechanization caused record crops, and gave promise for the end of world hunger.

We must still consider that one last burst of technological progress, in the two decades 1866-86, which was necessary to create the "modern times" witnessed in the twentieth century. America's amazing post-Civil War development was instigated and guided by the Philadelphia-based nationalists who had tutored and sponsored Abraham Lincoln. As we shall see, the spread of modern conditions to Japan and some other nations, and the electrification of the planet associated with the name of Thomas A. Edison, were both part of this last nationalist enterprise.

7. The 'Philadelphia Interests': the world after Lincoln

Following the American Civil War, U.S. statesmen, industry builders, military officers, scientists, and inventors in the nationalist faction fought against terrible odds to advance global technology and civilization. Assassins struck down their President in 1865, another President in 1881, and another in 1901. The nationalists were bankrupted in 1873, and U.S. government finances came under foreign control; piratical foreign representatives seized the great industries. By 1902, adherents of British policy governed the United States top-down, and blocked any further revolutionary technological advance.

Despite these obstacles, in the post-Civil War period the tightly knit nationalist faction created new infrastructure and industries which vastly expanded the power of man over nature, in the United States and abroad. Their crowning victory was the electrification of the United States and other nations by their protégé and fellow fighter, the inventor Thomas A. Edison.

"But wait!" the reader may be thinking. "Your history may suit a communist country, but not the United States. In capitalist countries, no one *planned* new technology. Sure, some inventors might have been idealistic at times; but money and the market drive our economy!" The idea that forethought and strategic purpose have guided man's progress, is perhaps even more unsettling to some people, than the thought that evil men conspire against that progress. This may be because, in 1996, such real progress is unthinkable, is banned by "budget cuts" and "ecology."

Yet, in 1870, there still existed a powerful American alternative to Wall Street, to British ideology. There was a general expectation of dramatic material progress; there were men and institutions determined to bring it about, and they had allies abroad. We report here on how some of the main industries were built, with their new technologies. In order to unmistakably *identify the strategists behind these enterprises,* we will review some of their other objectives, political and military; and explain how the nationalists were ultimately brought down.

At the heart of America's post-Civil War development, were the political and intellectual associates of Henry C. Carey and Alexander Dallas Bache, and the complex of government and private institutions they and their predecessors had built since Benjamin Franklin.

The nationalists' power revolved around the Pennsylvania Railroad (PRR), and the banking house of Jay Cooke. The PRR had been built in the late 1840s; the city of Philadelphia bought a quarter of the corporate stock to subsidize construction. In 1857, PRR President J. Edgar Thomson hired the young engineer William J. Palmer—to become the sponsor of Thomas Edison—as his personal secretary; Palmer converted the railroad from wood- to coal-burning locomotives. The Pennsylvania Railroad grew to become the largest American corporation, with 6,000 miles of lines.

During the Civil War, PRR executives Thomas Scott and Andrew Carnegie organized the U.S. military telegraph office. William J. Palmer became a cavalry general and was awarded the Congressional Medal of Honor. Philadelphia nationalist Jay Cooke raised $1 billion for the war effort: He sold U.S. bonds to ordinary citizens, and beat Wall Street's attempt to blackmail the President by denying credit to the government. Cooke continued marketing most of the federal government's bond sales after the war.

Thus a combination arose, involving banking, government, and Bache's naval and military connections, with immense potential power for technological transformation. At the center was economist Henry C. Carey, the grand old man of nationalist strategy. His books and articles defined the purposes of the nationalists' efforts. Carey's ideas informed the federal policy that protected the mills and kept federal finances out of the hands of the London-Wall Street banking axis. And Carey's behind-the-scenes relationships with the military, the scientists, and the pro-modern parties in each foreign country, were the web which held everything together.

By 1871-72 a unified set of large industrial companies was owned by a partnership, known informally as the "Philadelphia Interests," including J. Edgar Thomson, Thomas A. Scott, Andrew Carnegie, William J. Palmer, Matthew Baird, Samuel Felton, and others. They ran the Pennsylvania Railroad, the Baldwin locomotive company, the Denver & Rio Grande Railroad, the Pennsylvania Steel Company, the Kansas Pacific Railway, the Mexican National Railways, the Automatic Telegraph Company, and numerous other railroads, iron forges, machine builders, and coal mines.

Partner Andrew Carnegie was building the J. Edgar Thomson steel works in Pittsburgh, the world's largest and first truly modern steel mill. The Philadelphia Interests had just taken control of the Union Pacific Railroad, and had started George Westinghouse's career by installing his air brake on PRR trains.

Meanwhile the group's banker, Jay Cooke, with huge government land grants under Lincoln's law, began construction of the 2,000-mile Northern Pacific Railway.

The management of these enterprises overlapped with the Franklin Institute, the University of Pennsylvania and the American Philosophical Society. The cadres developed under Alexander D. Bache's leaderhip, and otherwise nested within this extended Philadelphia research/industrial complex, supplied the genius and drive for the most important U.S. engi-

neering and scientific endeavors. For example: Samuel Felton, president of several of the partners' railroads and steel companies, was the brother of Bache-Lazzaronian Cornelius C. Felton, who presided over vital scientific capabilities as president of Harvard College. Another example: Bacheite Benjamin Silliman, Jr. had published in 1855 a "Report on the Oil Rock, or Petroleum, from Venango County, Pennsylvania," on the chemical composition of underground oil and how to refine it; this was the beginning of America's oil industry, which was first promoted by the Philadelphia Interests.

Henry Carey's disciple Joseph Wharton, founder of the Bethlehem Steel Company, led the Washington D.C. lobbying on behalf of Carey and the PRR group. They secured protective tariffs so high as to block any British interference with U.S. development. Joseph Wharton founded the Wharton School of Business (later a school for swindlers and parasites) as a Careyite nationalist center.

British financiers open fire

In 1871, at the height of the nationalists' power, the British forged a new Philadelphia-New York-London axis that would be used to break the entire American political leadership. London banker Junius S. Morgan merged his New York son, J.P. Morgan, into the Austrian-origin Drexel banking house of Philadelphia. The new firm was "Drexel, Morgan"—later, J.P. Morgan & Co.

Anthony Drexel owned the *Philadelphia Ledger,* which had a joint editorial operation with the London *Times.* The *Ledger* began relentlessly slandering Jay Cooke, the main banker for the U.S. government and the Philadelphia Interests; they said Cooke was going bankrupt, that his depositors and lenders would lose everything. These articles were circulated throughout the world, while Drexel, Morgan coordinated an all-out war against Cooke's credit standing within the financial community. Furious "anti-corruption" propaganda by the Anglophiles against all railroad building had already caused the Congress to shrink from further support for Cooke and his colleagues, and Cooke was weakened. Drexel's campaign struck its target with explosive effect.

Jay Cooke & Co. folded and closed its doors on Sept. 18, 1873. Within two days the Northern Pacific and most other American railroad construction halted. The new steel mills shut down, banks collapsed, stocks crashed. In this Panic of 1873, the Philadelphia industrialists were totally removed from the transcontinental railroad business. The overall pace of development in the American economy was never again to be recaptured. The goal of densely settling populations along the western routes of transcontinental railroads was abandoned by the men who took over the lines.

In 1879, the year that Henry Carey died, the Specie Resumption Act was officially implemented, ceding sovereignty over U.S. monetary policy to the international holders of gold.

Britain's Newcomen Society gloated over the change: "Drexel, Morgan & Co. achieved a major position in the distribution of U.S. Government bonds, a field that previously had practically been dominated by the Philadelphia banking firm of Jay Cooke. . . . After Cooke was forced into bankruptcy by the Panic of 1873, the Drexel-Morgan firm held an unrivaled position in this field of finance. . . . To the United States Treasury, [Morgan] could now offer distribution facilities . . . [involving] Drexel-Morgan . . . J.S. Morgan & Co. in London, . . . [and] international distribution through Levi Morton and the Rothschild firm." In fact, those very British firms constituted a syndicate which had gained iron control over U.S. government finances.

But in the darkening 1870s, Henry Carey and his associates did not submit. We will here offer thumbnail sketches of four "projects"—three foreign nations, and one famous man's career—projects which were carried out under conditions akin to enemy military occupation, and which the nationalists would continue for a few crucial years after Carey's death.

Japan gets on the track

The U.S. nationalists had opened up Japan in the 1850s, when Commodore Matthew Perry brought a fleet loaded with a railroad train and a telegraph system; with U.S. backing, Japan went on to create a new pro-modernization government. In 1872, Japanese Prince Iwakura and much of his regime came to visit, staying in the home of Jay Cooke. His delegation was preparing a trade treaty and a loan of $15 million for Japanese development, and Cooke was negotiating for Asian connections with the Northern Pacific system. The allied nationalists envisioned a global belt of railways, canals, and shipping operations to vastly increase the effectiveness of their economies.

At that time Henry Carey's associates, led by geologist/industrial planner Benjamin Smith Lyman and economist E. Peshine Smith, were in Japan coordinating the American-allied government's identification of mineral resources, planning railroads, and outlining tariff strategies. This was the birth of Japan's industrial might.

The fiercely anti-British John Bingham became ambassador to Japan in 1873. Bingham hung on to his post through several U.S. regimes until 1885, battling British diplomat Harry Parkes for influence over Japan's destiny: Should it be a powerful technological republic or a British-model chauvinist empire, a plaything of British geopolitics?

The eventual collapse of America's nationalist faction was a tragedy for Japan as well as for the United States. The Japanese entered modern times on an American train, but the British sidetracked it.

Russia's western start

As America's most influential newspaper writer, Henry Carey had swung public opinion behind Russia in its 1854-56 Crimean War with Britain. Carey himself went to Russia in 1859, apparently to secure a U.S.-Russian alliance in the deepening U.S. sectional crisis. During the Civil War, Czar

Alexander II did send his fleet to New York and San Francisco to prevent British direct intervention on behalf of the Confederacy, and the United States began supplying ironclad warships to Russia.

Former Pennsylvania Gov. Andrew Curtin went to Russia as U.S. ambassador in 1869. Henry Carey hosted a send-off dinner for Curtin, where a U.S. general proposed that the czar should build a trans-Siberian railway, to link up with the United States, and to break British hegemony.

Carey's Philadelphia friend, George H. Boker, was ambassador to Russia from 1875 to 1878, and a new venture was undertaken.

The Russians appointed the publisher of Carey's polemical anti-British magazine articles, banker Wharton Barker, as Russia's American financial agent. In 1878 Barker built four battle cruisers for the Russian Navy in Philadelphia. Wharton Barker went to Russia to plan iron and coal mines, forges and factories, for the transformation of southern Russia. He formally proposed that the two nations prepare as allies for a war against Great Britain, aiming at "the accomplishment of the common work of Russia and America, namely the dismemberment of the British Empire."

Wharton Barker and his closest associates brought about the nomination of their candidate, James A. Garfield, who was elected U.S. President in November 1880. The czar signed the industrial development contracts with the Philadelphia organization on March 10, 1881; on March 13, Czar Alexander II was assassinated. One week later, Garfield was inaugurated; President Garfield was shot in July, and died in September. The new czar, Alexander III, continued some of the proposed southern Russian development, but now without participation by the clearly dangerous Philadelphians.

Count Sergei Witte, an advocate of Friedrich List's nationalism, would build Russia's Lincoln-style trans-Siberian railway and begin the country's industrial modernization in the 1890s. But the Russian Revolution overthrew Witte, and cut the American tie.

Ireland and the Carey submarine

One hundred years after Mathew Carey had become an Irish revolutionary, his son, Henry Carey, plunged in and took responsibility for reviving the Irish struggle for independence from Britain. Carey's disciple, Philadelphia Irish immigrant physician William Carroll, was designated head of the Irish revolutionary underground—the Fenians, or *Clan na Gael*—in 1875. Dr. Carroll was chairman of the Clan na Gael executive committee from 1875 to 1880; he was backed in the movement's leadership by other Carey allies, notably Knights of Labor chief Terence V. Powderly, and University of Pennsylvania economics Prof. Robert Ellis Thompson.

Carroll and his colleagues sent cash and guns to Ireland, and in 1878 Carroll toured the British Isles, reuniting the bickering Irish underground into a cohesive force of 20,000 members. (Twenty years later this Careyite initiative would result in the formation of the Sinn Fein, which went on to free most of Ireland from British rule.) Dr. Carroll's main partner in this work was Irish revolutionary John Devoy, who had become foreign editor for James Gordon Bennett, Jr.'s *New York Herald*. Several others of the Carey-allied Irish nationalist movement joined Devoy in guiding the *Herald*—a newspaper that would be useful to Thomas Edison.

Perhaps Dr. Carroll's most spectacular enterprise was the invention of the submarine. The *Clan na Gael* "skirmishing fund" paid Irish immigrant John Holland approximately $60,000 to build prototype underwater warships; Carroll justified the expenditure by reference to Robert Fulton's similar craft in the 1790s. The three-man submarine *Fenian Ram* was tested in New York harbor in May 1881; the British embassy protested, but Garfield refused to interfere with the Irish operation. (Garfield died soon afterwards.) The U.S. Navy in the 1890s decided to revive the *Clan na Gael*'s project, and paid John Holland to build the Navy's first battle submarines.

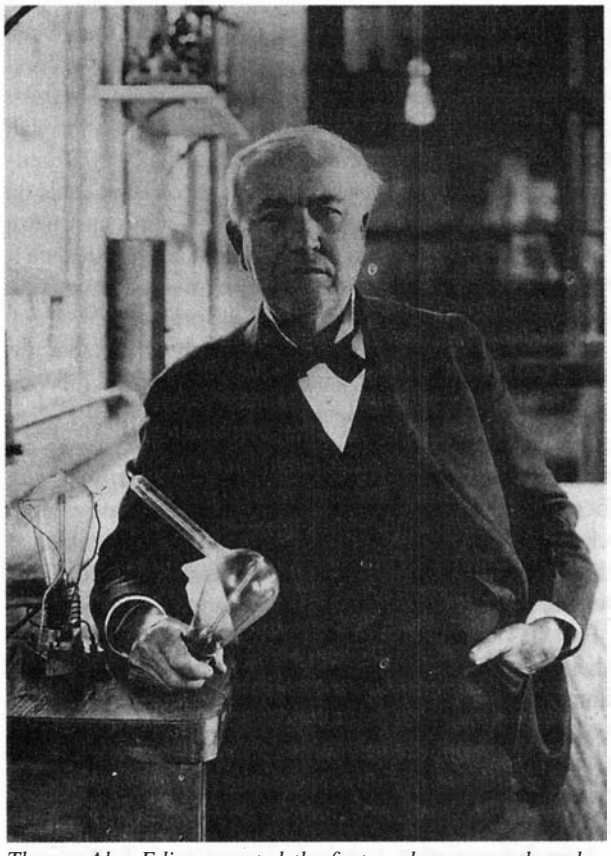
8. The real Thomas Edison

Thomas Edison was called by admirers "the Franklin of the nineteenth century," and it is not surprising that he should be slandered by his detractors precisely as was Franklin: "a mere tinkerer," "uneducated," "unscientific," "an empiricist." The Dec. 31, 1995 *Washington Post* labeled Edison "a grease monkey. A putterer. A mechanic." As the lie was put about, that Franklin was a "British agent," so has Edison been called a Wall Street stooge. It is said that J.P. Morgan sponsored Edison's work, or that speculator Jay Gould gave Edison his start.

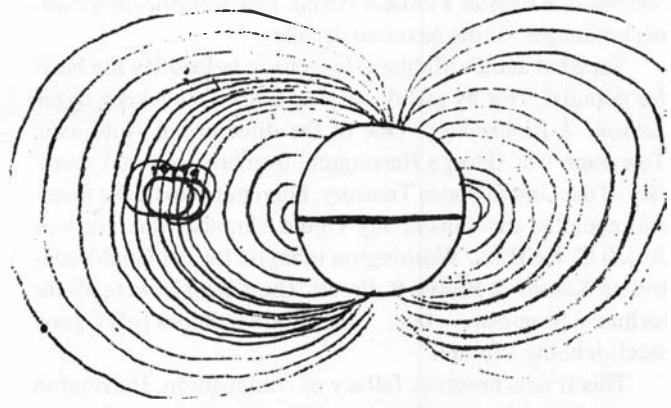
These and other calumnies constitute an outpouring of Anglo-establishment rage which is puzzling until one knows who Edison really was.

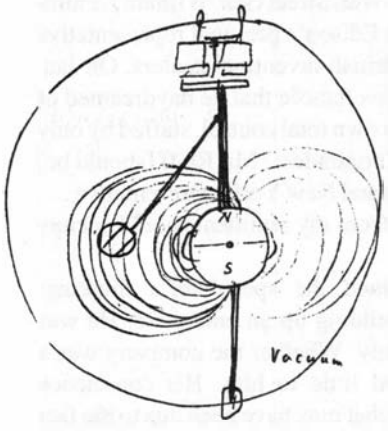
At the height of their power, the Philadelphia industrial-scientific-political grouping (see previous sections) *discovered Thomas Edison* as a young, clever inventor of telegraphic devices. They set him up as an independent full-time inventor. They encouraged him into astonishing inventions. When they were grievously weakened, financially and politically, they schemed to make Edison famous. Recognizing the force of his genius, they asked him to invent the electric light and tutored him in the history of the field. They protected Edison as far as possible from the brutal sabotage of J.P. Morgan, their enemy, and they stayed with Edison, through to the victorious electrification of the world.

The following report is, as far as is known, the first published attempt to systematically account for Edison in his real relations to the "principalities and powers," and to see Edison's own thinking in the context of America's technolog-



Thomas Alva Edison created the first modern research and development laboratory, an "invention factory" to transform the world, just as Leibniz had proposed. Edison perfected the telephone, and invented electric lights, the electric power industry, sound recording, and motion pictures. He is shown here with the "Edison effect" lamp.





Entries in Edison's notebooks, 1886. Edison hypothesized on the force geometries shaping the solar system, and theorized that overlapping force lines from the Sun and the Earth produced the Earth's rotation. Left, an "apparatus to prove the theory." Like Franklin, Edison had no use for Isaac Newton's dead, purposeless universe.

ical optimism—something considered quite "incorrect" today.

It was William Jackson Palmer who directed the initial rescue of Edison out of Wall Street's employ. By the end of the Civil War, Palmer had become a full partner in the "Philadelphia Interests." He had converted the Pennsylvania Railroad to coal. As a Union officer, his cavalry had routed and captured an entire Rebel regiment in Alabama. The partners in 1866 sent Palmer and his assistant, telegraph expert Edward H. Johnson, out west to build the Kansas Pacific Railroad.

Backed by their industrial power, and the land grants and greenback-issuance policies put in place by President Lincoln, Palmer and Johnson surveyed the Kansas Pacific route through untracked wilderness in New Mexico and Arizona to the West Coast, and built the line from Kansas City, Missouri to Denver, Colorado. Johnson served as telegraphic constructor, surveyor, and Palmer's secretary. With Johnson's assistance, Palmer began building a line from Denver to Mexico City, with plans to develop modern manufacturing in both of the United States' North American sister republics.

But Wall Street was pressing everywhere to take over and milk or destroy productive enterprises. Jay Gould would get into the Kansas Pacific; the Boston Brahmins would move to shoot down Palmer's operations.

Backed by the Philadelphians

In 1870, Palmer, one of his Kansas Pacific executives named Josiah Reiff, and Philadelphian George Harrington, formerly Lincoln's assistant secretary of the treasury, set up the Automatic Telegraph Company in New York City. The firm was supposed to compete with the Western Union Company, which only bought inventions in order to silence a potential challenge to its communications monopoly, and would suppress or make use of them as necessary.

Palmer sent Johnson back East to supervise Automatic's work, and Johnson hired the 24-year-old Thomas Alva Edison to invent their technology. Edison had made a name for himself as an employee or contractor developing telegraphic devices, but Wall Street had hemmed him in. The Automatic Telegraph Company now gave Edison $40,000 to set up a new shop; Reiff later arranged that Edison would be on salary

while doing his telegraphic inventing. Edison accepted on condition that Johnson be assigned as his chief assistant. Johnson became Edison's closest friend, and was Edison's business manager for the next two decades.

Socialist author Matthew Josephson helped lay the basis for populist error by misidentifying Edison's backers, in his *Edison: A Biography:* "One of the directors of Automatic Telegraph was George Harrington, formerly assistant secretary of the United States Treasury, but reputed to be the financial agent of the sinister Jay Gould. Another director was Josiah C. Reiff . . . Washington lobbyist for the Gould-controlled Kansas & Pacific Railroad. These people were all for technical progress . . . but . . . they were in hopes [of] a good stock-jobbing venture."

This is anachronistic fallacy of composition. Harrington eventually sold out to Gould; and Gould was contending for and eventually took over the Kansas Pacific. But Reiff, and Automatic's international representative Colonel Gouraud, were both agents of the anti-Wall Street Gen. William J. Palmer. Gouraud would become Edison's personal representative in England, dealing with British invention-stealers. On Jan. 17, 1870, Palmer wrote to his fiancée that he daydreamed of an "ideal railroad" under his own total control, staffed by only his closest and most trusted comrades: "Mr. Reiff [should be] general agent, Colonel Gouraud New York representative . . . and a host of good fellows from my regiment should occupy . . . various positions."

Edison himself explained the speculator's thinking: "Gould took no pride in building up an enterprise. He was after money, and money only. Whether the company was a success or failure mattered little to him. His conscience seemed to be atrophied, but that may have been due to the fact that he was contending with men [of Western Union] who never had any to be atrophied."

To understand Edison's mental map, it helps to consider the background of his Canadian immigrant father, Samuel Edison, who assisted Thomas in his Automatic Telegraph work and would construct his famous Menlo Park, New Jersey laboratory. Like Henry Carey's father, Mathew Carey, Thomas Edison's father was indicted for treason against the British Crown. Samuel Edison organized his townsmen against British rule, and, in 1837, he was forced to flee through the woods from British troops pursuing him. He escaped across the river-border from Ontario to Michigan, and later moved to Ohio, where Thomas was born in 1847.

Attacking a problem

Johnson described Edison's probe of everything ever done before on the telegraph problem under study—how to send several messages simultaneously on the same wire, at high speed:

"There were numerous theoretical solutions in French books, but none of them enabled him to exceed the rate of 200 words a minute. . . . I came in one night and there sat Edison with a pile of chemical books that were five feet high when laid one upon another. He had ordered them from New York, London and Paris. He studied them day and night. He ate at his desk and slept in a chair. In six weeks he had gone through the books, written a volume of abstracts, made 2,000 experiments . . . and produced a solution, the only one that could do the thing he wanted." Edison wrote, "I would construct a theory and work on its lines until I found it untenable, then it would be discarded and another theory evolved. This was the only possible way for me to work out the problem."

In 1876, Edison moved into the new Menlo Park laboratory, the "invention factory," with the Philadelphians' Johnson as his chief executive assistant. Alexander Graham Bell had recently developed a toy-like telephone device, somewhat better than two cans on a string, which could be used with difficulty over a short distance. Edison and his staff went to work to perfect the telephone; by 1877, he had invented the carbon transmitter and microphone, making the telephone practical.

Bell was backed on Wall Street by Boston's John Murray Forbes, a Baring Bank ally and head of the Boston-to-China opium syndicate; Forbes's son Hathaway would be Bell Telephone's first president. Edison, Johnson, and Colonel Gouraud created a rival telephone company and fought it out for preeminence in England itself against the Bell forces; the rival British companies eventually merged.

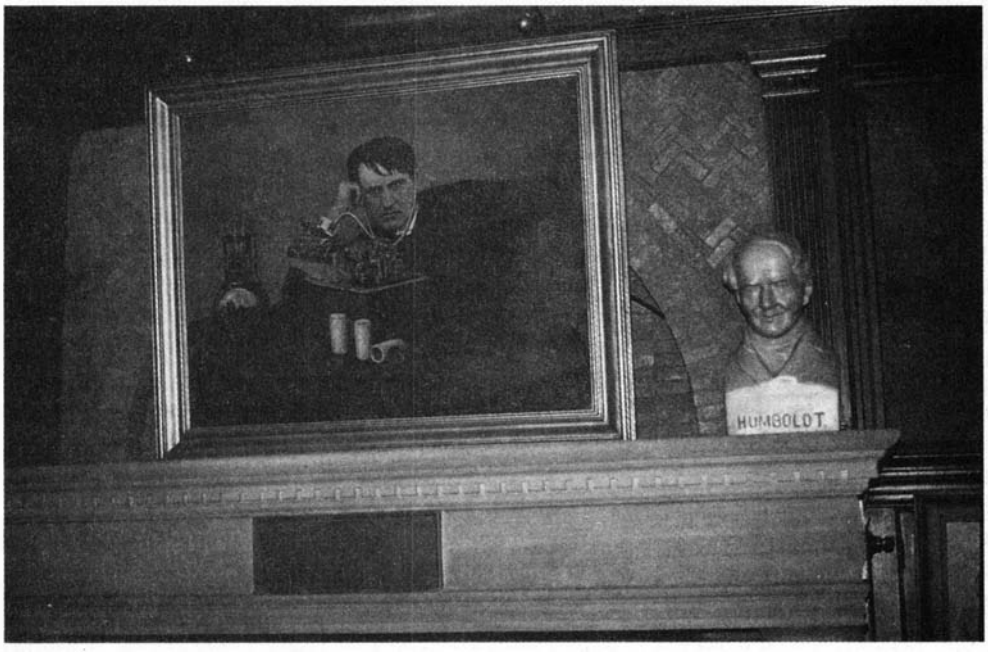
A few years earlier, Edison had met George F. Barker, a professor of physics at the University of Pennsylvania. Barker (no known relation to Wharton Barker) was chief scientist at the Franklin Institute, resuming Alexander D. Bache's role. Professor Barker became Edison's scientific "angel" and dear friend.

Inventing the phonograph

The Bell-Edison telephone was going to market, and Edison asked: What if you call someone, and he is not in? The voice must be somehow preserved. Professor Barker encouraged Edison to take up the solution to the question—the invention of the phonograph. Edison had been partially deaf since childhood, but had trained his concentration so he could hear the entire musical overtone series. He loved Beethoven and hated Wagner; he worried that his new instrument could not reproduce a truly beautiful sound, and warned against its use for bad popular musical entertainment.

Once the phonograph was tested successfully, the embattled Philadelphia nationalists set out to make Edison famous.

Professor Barker arranged for Edison to be invited to the April 18, 1878 Washington, D.C. meeting of the National Academy of Sciences, an institution founded by Bache for loyal scientists during the Civil War. Barker and his friends made sure that the hall was packed with a warmed-up audience. The first words of the device to the public were, "The Speaking Phonograph has the honor of presenting itself to the Academy of Sciences."



The Edison Museum in West Orange, New Jersey, displays a portrait of Thomas Edison alongside Edison's bust of German scientist Alexander von Humboldt. Edison considered Humboldt the father of American science.

That night, a demonstration was held for the press in the Washington bureau of the *Philadelphia Inquirer*. The next day, with the cooperation of nationalist political leader James Blaine (soon to be President Garfield's secretary of state), the phonograph was demonstrated for congressmen in the home of Blaine's niece.

This publicity, organized by the Philadelphians and their political allies, made Edison world-famous.

To see a little bit of the connection between Edison and his political backers, we advert to a message from Professor Barker to Edison on March 22, 1878. Barker telegraphed that he wanted to hook up a direct telephone line from Menlo Park into the University of Pennsylvania for his forthcoming lecture. Barker then asked Edison, "Would it be too much of a favor to ask that you allow someone at your shop to give me occasionally a little time for experiment? For example I am to have at the University on Wednesday next, some of our most prominent men, Mr. Henry C. Carey, [Careyite journalist] Mr. Morton McMichael, Mr. Geo. H. Boker [former ambassador to Russia] etc. to see the telephone (the Bell [and two other devices]) and I should be very glad to use that opportunity to show them the greatest of the telephones, Mr. Edison's. Could you let someone do some talking [i.e., on the telephone from Menlo Park to the lecture-demonstration for Henry Carey et al.] about 4 p.m. on that day?" A few days earlier, General Palmer had written congratulations to Johnson: "Edison's last developments beat Aladdin completely."

The fight for light

In July 1878, Professor Barker invited Edison to travel with him by the new railroad to Wyoming, to view a solar eclipse, and on to the West Coast. On this trip of two months, Barker reviewed with Edison the development of electrical science, and the recent attempts to create light from electricity. *Barker proposed that Edison take this up as his own great project.* On Sept. 8, Barker next took Edison to Connecticut, to view an arc light (a bow of flame between two adjacent electrodes, unsuitable for indoor use) and a water-powered generator. Seeing a problem posed, and that no one was on the track to a solution, Edison excitedly took up the challenge.

Edison's object was to electrically heat, and cause to glow, some material ("filament") contained inside a glass, without consuming it; to "divide the light," by having an unlimited number of such devices running on the same power source; and to create a steam-driven generator that would convert fuel burned into electricity with such efficiency that the new light would be at least as cheap as the gas lights then in use.

Early the next month, October 1878, Edison boldly announced to the newspapers that he had invented the electric light, that he would produce light and electric power universally for the cities, thus moving civilization to a new stage.

Edison was confident he could do what he claimed. But the Philadelphians were staggering financially; Edison and his friends would have to get cash to move the work to completion. And those who controlled the main sources of available funding, Britain's U.S.-based financial agents, viewed Edison with alarm.

J.P. Morgan, his partner Anthony Drexel, and Rothschild representative August Belmont all came to Menlo Park in early December to negotiate for rights to Edison's yet-to-be-created electric light. Morgan immediately incorporated his Edison Electric Lighting Company (EELC).

Knowing that the London-New York financial axis wanted control so that they could suppress his work, and faced with

Morgan's lawyer Grosvenor Lowry's demands for secrecy, Edison used publicity to educate a broad range of supporters and potential financial backers.

The *New York Herald,* with its Irish underground editors, was Edison's special champion. A particularly influential article in the Dec. 21, 1879 *Herald* precisely and scientifically detailed the history of Edison's work on light and power up to that point, describing the result as "a bright, beautiful light, like the mellow sunset of an Italian autumn"; the author had accompanied Edison and Professor Barker on their trip out west.

The British scientific establishment and their American hangers-on churned out incessant, scornful anti-Edison propaganda. A special committee of Parliament heard experts testify that the electric light was impossible, and electric power would be dangerous in the general public's use. Sir William Preece told the Royal United Service Institution on Feb. 15, 1879:

"It is . . . easily shown (and that is by the application of perfectly definite and well-known scientific laws) that in a circuit [with constant] electro-motive force . . . additional lamps [inserted] . . . in series [will cause a sharp diminution of the light in relation to] the number inserted. Hence a sub-division of the electric light is an absolute *ignis fatuus.*"

Among the attacks against Edison in the *New York Times* was an interview with a prestigious scientist, Henry Morton, pronouncing the whole electric light idea a failure, and repeating the British line that "no sub-division of the light is possible."

The nationalists' *New York Herald* replied, referring to the British heart of the problem: "Mr. Morton . . . will not have [the electric light] on any terms, and when a man of his eminence . . . refuses to consent to the electric light it is but little short of impertinence for Mr. Edison to invent it. . . . As Lord Russell [former British prime minister] was willing to consent that the progress of the British people might be admitted to go so far as he approved, but held that the point so gained must be a finality, so this professor will not admit that there may be any movement in the progress of invention beyond his finality; which is gas."

At length, Edison made his impossible light, his unlawful dynamo, and the hundreds of other inventions necessary for a working power system. Morgan blocked the manufacture of light bulbs, preferring to simply hold the patents. So Edison sold stock in the EELC and he and Johnson set up the Edison Lamp Company to make the bulbs.

A single power station was established, at Pearl Street, New York. The Morgan-controlled EELC bluntly refused to allow any more generators to be built. But the overwhelming public faith in Edison's competence made it likely that other money sources could somehow be found, and a brawl on the EELC board loosened Morgan's stranglehold for a time. Edison now proceeded with the spread of electricity the way the nationalists had built railroads before the Civil War—*municipalities issued their own bonds to pay for the building of power stations.* Production of dynamos and their installation grew rapidly. Large city central power stations rose to 12 in 1884, and to 58 in 1886. By 1888, Edison had installed 200 central lighting stations and 1,500 isolated plants (and he held about $4 million in municipal bonds).

Edison's power stations brought electricity to South America and Japan. Johnson and Professor Barker spread Edison's systems to Europe. German industrialist Emil Rathenau became Edison's partner in Germany. Rathenau was the opponent of the British-controlled Siemens company, whose 40% efficient dynamo had been bested by Edison's 90% rating. So it was Rathenau's Edison company, later called Allgemeine Electrizitäts Gemeinschaft (AEG), which turned on the lights in Berlin and electrified German industry.

'He couldn't solve a simple equation'

Who, then, really, was this man who brought light and power to the world?

With a mind that demanded problems to solve, that fought for solutions, Edison received direct support from America's best scientific thinkers, who had been trained in the milieu of Gauss and Humboldt. Edison's bust of Alexander von Humboldt sits in the Edison laboratory historic site in West Orange, New Jersey.

Edison's notebooks contain countless thousands of experiments and free explorations of much of the domain of science. His working hypotheses on the nature of gravity as electromagnetism, including his picturing of the origin of the earth's rotation in terms of the overlapping lines of force of the Sun and the Earth, are in the tradition of Johannes Kepler's work—and a challenge to the Newtonian dogma that separates gravity from electromagnetism.

At one point, J.P. Morgan's men brought in the young Francis Upton, trained by the prestigious Newtonian Hermann Helmholtz, to serve as "expert mathematician" to the presumably crude Edison. But, after a time, Upton confessed himself Edison's scientific inferior. Yet the man who brought Upton in, Francis Jehl, later bitterly complained to Upton that Edison had "such real little knowledge, a man that cannot solve a simple equation."

Edison attracted to himself fanatically dedicated young researchers, in the post-Civil War era of hope and determination to remake the world. Edison's laboratories were the first modern R&D facilities, in line with Leibniz's "Academy" proposal for "institutions of research and development with their own manufacturing and commercial houses directly attached . . . [to] offer a just, low price for merchandise. . . . The trading monopolies will be eliminated."

Edison's economic ideas were terrifying to the rentier financiers. As he put it, "The company with the best and cheapest machinery will do the business. . . . Fact is . . . all electric machinery is entirely too high now. These high prices hurt the business. With the leaden collar of the Edison Electric Light Co. all around me, I have never been able to show what

can be done. The ground of cheapening has scarcely been scratched. Let us break the leaden collar and you will see a brainy competition that will show them what real competition is. . . . [Prices] must go down 50 to 75% lower than now . . . and we will make a great profit."

Among the assistants trained personally by Edison were Henry Ford, who created the automobile industry, and Frank J. Sprague. Sprague worked with Edison on electric trains, then formed a new company led by the Philadelphian Edward Johnson; they developed the electric subways, the elevators, and many basic electric industrial tools.

The Edison companies, like all the great American industries, were usurped by Morgan and related British-approved financiers. No significant new technology is attributable to those financiers, to Wall Street, or to the "magic of the marketplace."

Bibliography and acknowledgments

The author gratefully acknowledges the research and counsel of the following persons in preparation of this article: Richard Black, Elliott Greenspan, Laurence Hecht, Denise M. Henderson, Carol Hugunin, Robert Hux, Michael Leppig, Alan Levinson, H. Graham Lowry, Arthur Murphy, Richard Sanders, the late Richard Sober, Charles B. Stevens, and Philip Valenti.

Many of the facts presented in this study are quite widely known, but they are not thought to be especially significant. Perhaps this may be attributed to the brain-death typical of academia, as much as to historians' Anglophilia or other prejudice.

Thomas Edison is a good case in point. Virtually every standard Edison biography mentions that a certain Prof. George F. Barker was Edison's science adviser and that he asked Edison to invent the electric light. And most biographies note that a certain Edward H. Johnson was Edison's best friend and business manager. But no biography really inquires into who these people were, where they came from, or what was on their minds.

A large volume of correspondence involving Edison and these two men, a vast array of Edison's notebooks and other treaures, are in the Thomas A. Edison papers, which are now available on microfilm at major libraries.

Some of the research for this article was done in the Duke of Bridgewater papers at Salford University, Salford, England; Matthew Boulton papers, Birmingham City Archives, Birmingham, England; Henry C. Carey papers, Pennsylvania Historical Society, Philadelphia; William J. Palmer papers, Pennsylvania State Library, Harrisburg; Wharton Barker papers, Library of Congress, Washington; records of the 1837 rebellion (for Edison's father), National Library, Ottawa, Canada; and the George F. Barker papers, University of Pennsylvania archives, Philadelphia.

Some sources readers may find particularly useful:

Ellis L. Armstrong, ed., *History of Public Works in the United States, 1776-1976* (Chicago: American Public Works Association, 1976). Many interesting facts are presented, but it is lacking the necessary history of public *policy.*

Robert V. Bruce, *The Launching of Modern American Science, 1846-1876* (New York: Alfred A. Knopf, 1987). This contains useful facts about Alexander D. Bache's "Lazzaroni" grouping, but Bruce doesn't have a clue about the philosophy, politics, or scientific method of his characters.

Henry C. Carey, *Principles of Social Science,* 1858, reprint (New York: Augustus M. Kelley, 1963). Lincoln would certainly have read this three-volume work, widely circulated just prior to the Civil War.

Anton Chaitkin, *Treason in America, from Aaron Burr to Averell Harriman* (New York: Campaigner Publications, Inc., 1985).

G. Waldo Dunnington, *Carl Friedrich Gauss: Titan of Science* (New York: Exposition Press, 1955).

Joseph Henry, "Eulogy on Prof. Alexander Dallas Bache," in *Annual Report* of the Smithsonian Institution (Washington D.C.: Government Printing Office, 1870).

H. Graham Lowry, *How the Nation Was Won: America's Untold Story 1630-1754* (Washington, D.C.: Executive Intelligence Review, 1988).

Merle M. Odgers, *Alexander Dallas Bache* (Philadelphia: University of Pennsylvania Press, 1947).

Allen Salisbury, *The Civil War and the American System: America's Battle with Britain, 1860-1876,* 1978, reprint (Washington, D.C.: Executive Intelligence Review, 1995). Henry Carey's work is excerpted and placed excellently in context.

Nancy Spannaus and Christopher White, *The Political Economy of the American Revolution* (New York: Campaigner Publications, Inc., 1977); to be reprinted in 1996 by Executive Intelligence Review. Many extracts from America's founding nationalists.

Since such historical figures as Franklin, Hamilton, and Lincoln acted on philosophical grounds which are today considered incorrect or dangerous, their own writings should be read in preference to most secondary works about them, which often range from pointless to deceitful.