If nineteenth-century Philadelphia continued to be regarded as the scientific capital of the nation, its position of eminence was an inheritance of the original investigative minds of the eighteenth century, when, in addition to the University, “the conjunction of the American Philosophical Society, William Bartram’s botanic garden, Rittenhouse’s observatory, and Charles Willson Peale’s museum gave Philadelphia a good claim to being the cultural center of the new republic.” At the turn of the century, when the University of Pennsylvania moved to the building at Ninth and Market Streets originally constructed by the Commonwealth as a residence for the president of the United States, it was in a position to benefit from its location even though its fortunes were at a low ebb at the time. In the first decades of the century, problems of finance and discipline were plaguing all the institutions of higher learning so proudly established in the colonial period. At the University of Pennsylvania, the problem was compounded by the unequal weight of a prestigious, self-perpetuating board of trustees and an ill-organized faculty of four or five professors, with no president—as there was elsewhere—to adjust the balance. Meanwhile, American colleges in general were acquiring a reputation for “riots and rebellion . . . and unpunished dissipation.”

Frederic Beasley who became provost in 1813 realized that much of the indiscipline could be attributed to the extreme youth of the students. He proposed that the age of students entering the University should be raised from fifteen to sixteen as well as suggesting minimum entrance requirements—an innovation at the time. The University course was extended to four years in 1826. Despite all efforts at improving the situation, disciplinary action against student ring-leaders was difficult everywhere. Nonetheless, Harvard expelled forty-three students after the “Great Rebellion” of 1823, and expulsions and withdrawals also occurred at Yale, where the dying behest of one president was that “discipline may be preserved.”

In 1828, the Pennsylvania trustees took radical action by vacating all the professorships in the department of arts. The faculty was so small that the reorganization did not have an overwhelming impact
although it did permit the trustees to pension off the fifth provost. His indignation on being removed from office is reminiscent of the complaints of the first provost, William Smith. "Am I to be considered as responsible," protested Beasley, when the structure of the University was "acknowledged on all hands to be so radically defective in itself . . . operating in the midst of a population so unconcerned about its interests?" Fair or not, the reorganization was beneficial to the University. One of the new faculty was Robert Adrain, the most gifted mathematician in America, who had previously taught at Princeton and Columbia. Among his original contributions, he gave the first proof of what is now known as Gauss's exponential law of error, which, had the work been done in Europe, would almost certainly have been named after Adrain.

Another result of the trustees' action in 1828 was the appointment of a young Philadelphian to the professorship of natural philosophy and chemistry, a position which had been held in turn by the two scientifically oriented provosts, Smith and Ewing. The new professor, Alexander Dallas Bache, was only twenty-two at the time of his election, having graduated from West Point in 1825. A member of one of Philadelphia's most distinguished families, he was the bearer of a notable tradition in both science and politics. Some years later, at a time when Bache became the most influential regent of the newly established Smithsonian Institution, his uncle, George Mifflin Dallas, was the Vice-President, and one of his wife's uncles was a Senator who later became Secretary of the Treasury, a position formerly held in Madison's cabinet by Professor Bache's namesake, Alexander Dallas. His most celebrated ancestor, however, was his great-grandfather, Benjamin Franklin.

The young professor was well aware that his famous forebear had been associated with all the institutions where he, in turn, was carrying on his own investigations, and he made a point of underlining Franklin's priority in a number of scientific observations. Even though Bache himself made great contributions to science and to its organization on a professional basis in the United States, his contemporaries constantly alluded to his intellectual genealogy. Thus his famous Swiss colleague, Louis Agassiz of Harvard, addressed him as "the learned Grandson," in the same way that his West Point classmate, Jefferson Davis, hesitated between grandson and great-grandson in his memoir. Throughout his life, Bache encountered reactions similar to that of an elderly German savant: "Mein Gott, now let me die, since I have lived to see an emanation of the great Franklin."

Alexander Dallas Bache grew up in Philadelphia during the University's most difficult days. With his family background of government service, both civil and military, he was sent, before his fifteenth birthday, to Sylvanus Thayer's young but already distinguished United States Military Academy. He graduated first among a distinguished group of cadets, and his classmates later recalled, with more enthusiasm than accuracy, that
During the whole term of his course at West Point, he never incurred a single mark of demerit.” Although this exemplary record has found its way into the Dictionary of American Biography, the Academy’s conduct book, nonetheless, registers a number of minor infractions on his part. It appears, however, that Bache was liked and respected from his earliest youth, and throughout his life he continued to be highly regarded as an original investigator, a gentle, persuasive educator, and a hospitable and tactful politician whom Benjamin Peirce, the Harvard mathematician and astronomer, sometimes addressed in his flowery letters as “My Darling Chief.”

With the appointment of Bache, the trustees acquired a professor with a brilliant academic record, and a small amount of previous teaching experience, who, for some reason, encountered none of the disciplinary problems experienced by many of his contemporaries. In a eulogy in 1872, his lifelong friend, the physicist Joseph Henry of Princeton and the Smithsonian, wrote:

His pupils could not fail to be favorably impressed by his enthusiasm and influenced by his kindness. He always manifested an interest not only in their proficiency in study, but also in their general welfare. They regarded him with affection as well as respect, and while in other classrooms of the university disorder and insubordination occasionally annoyed the teachers, nothing was to be witnessed in his, but earnest attention and gentlemanly deportment.

During his tenure at the University there is no record of any complaints against Bache in the Minute Book. His practice appears to have been in keeping with his stated approach—one whose value was by no means widely recognized at the time:

The strictest discipline is, in my opinion, consistent with kindness of feelings and mildness of action. Punishments are, no doubt, necessary in a school; and the good sense of a community of young people recognises, at once, when punishment is applied as a means of correcting bad habits and propensities; or when administered in the spirit of revenge.

In his second year at the University of Pennsylvania, Bache became secretary to the faculty. In this capacity, he was obliged to record the many complaints arising from lack of discipline in the classroom. The problem was usually one of rowdy behavior, in which lectures were interrupted by odd noises or drowned out by the shuffling of feet or, occasionally, by eggs being thrown at the professors. Bache also signed the letter of acceptance sent to the parents of the twenty-eight freshmen admitted in 1829. As an official communication from the secretary, it gives a good idea of the priorities of the era. Punctuality and diligence and orderly conduct in chapel are demanded of the student, who is “required to demean himself
Henry Vethake (1792–1866)
Photograph by M. P. Simons
Professor of mathematics and then of moral philosophy (1855–1859), and vice-provost and provost of the University of Pennsylvania. Born in British Guiana, A.B. Columbia University (1808), he was professor of mathematics and natural philosophy at Queens College (Rutgers), the College of New Jersey, New York University and president of Washington College, Lexington, Virginia, before coming to the University of Pennsylvania. Trained as a mathematician and astronomer, he wrote two pioneer treatises, an Introductory Lecture on Political Economy and The Principles of Political Economy. In his economic studies, he dwelt on the law of diminishing returns.
for measuring the dip and intensity of terrestrial magnetism, and during his travels he acquired apparatus designed by Gauss himself.

By this time, Bache had already published papers on the variation of the magnetic needle in the American Journal of Science and the Journal of the Franklin Institute. His study of magnetism led later to his appointment as superintendent of the United States Coast Survey in which an immense triangulation from Maine to Florida was only the point of departure for a vast range of projects. On the other hand, early experiments concerning heat came to a premature end. According to the University of Pennsylvania chemist Provost Edgar Fahs Smith, his paper entitled "Inquiry in relation to the alleged Influence of Color on the Radiation of non-luminous Heat" is a scientific classic. As recounted by his friends, however, the story behind the termination of this project bears witness principally to his self-control and sweetness of temper:

One room on the sunny side of his house was appropriated to these experiments; the various thermoscopes and all the subsidiary apparatus were arranged there, and the apartment was held sacred to scientific investigation. One evening, while he was attending a session of the Philosophical Society, an alarm of fire broke out in the neighborhood. His mother, then a member of his family, heard the alarm, and hastily entered the room without a lamp, to look from the front window. A crash reminded her, too late, of the inconsiderateness of her movements.

On learning of the accident, Bache went out again, "white with emotion," but he returned shortly afterwards and consoled his mother for the effects of her clumsiness.

It appears that Bache's equable temperament was responsible for his ease in handling students. Since disorders continued to plague the classrooms of many professors regardless of their field, his success cannot be attributed merely to the fascinations of the subjects of physics, chemistry, and geology. In fact, Joseph Henry compared him with such notable contemporaries as Priestley, Davy, Dalton, and Faraday as an example of how "it is precisely among the most celebrated explorers of science of the present century that the most successful and noted teachers have been found." Bache was at all times engaged in a broad variety of experiments and investigations, and his case refuted the view that researchers do not make good teachers.

Because of a keen interest in education in general, Bache was willing to give up his work at the University and in experimental laboratories to undertake an investigation of school systems in Europe. In 1832 an enormous sum of money had been left by Stephen Girard to endow a college for orphan boys. Bache was elected president of Girard College at a time when he had already been a professor of the University of Pennsylvania for eight years and a trustee of the proposed new college for
three; by then, he was thirty years old. Girard College was not to open until eleven years later and Bache had resigned from his position long before that time. Nonetheless, he completed a thorough study of methods of education abroad. For two years, Bache spent time visiting the major school systems in Europe. On his return, he volunteered to organize the public school system in Philadelphia, and his vast experience helped to produce the best system of free education in the country. Indeed, Central High, the degree-granting school of which he became the first principal, was known for a time as the Bache School.

The educational approaches he observed during his travels abroad ranged from the methods of Pestalozzi in Switzerland to those of Thomas Arnold of Rugby. Although he was not permitted to attend a class in any of the English public schools, he found much to interest him in the British schools for younger children. He recommended German secondary education, notably the system he found in Prussia, but preferred the training given to teachers in the normal schools of France. In a general comment he assailed the amateur status given to theories of education at the time: "Few persons claiming to be enlightened go to those unlearned in medicine for advice; & still fewer do not resort to the lawyer when litigation is to be commenced or avoided, but every one erects himself into judge of what may be taught in schools & how it must be taught." In his own approach to the subject, Bache displayed the analytic approach of the scientist. When the trustees of Girard College demanded an interim report, he pointed out that this could not be furnished by an objective investigator who, as he did not start out with preconceived opinions, was also averse to jumping to premature conclusions.

Not only did Bache acquire a particularly favorable impression of education in the German states, he returned with a lasting attachment to hock. His German wines were an element of some importance in his well-known hospitality in later life. As a visitor from Philadelphia, he further noted that Unter den Linden in Berlin was "wider than Market Street." In addition to the notes of his 666-page Report on Education in Europe to the Trustees of Girard College for Orphans, Bache kept journals in which, like many of his traveling countrymen, he recorded impressions of men and places. Among these is an amusing portrait of a nineteenth century "American tourist." Bache classified him according to his bearing:

He talked to every one who could speak his vernacular, and spoke to every one who would give his broken French an answer. His meals were bolted down in haste. He fidgeted lest he should lose anything of the moon or sun rise, and actually, turned out to witness the former in regular Kickapoo style, wrapped in a blanket. . . . He was off among the first in the morning, and after the day's journey we met him in the evening at Meyringen, still talkative as ever, and his tones certifying that he came from east of the Hudson; so far, the very beau-ideal of the American figured by tourists.
In pursuing the subject more attentively, Bache discovered that "this undoubted American was last from Thread and Needle Street, and had been born and bred in the old country." Apparently, even in the nineteenth century, European stereotyping and American self-consciousness led to false generalizations on national characteristics.\(^{21}\)

One unequivocal impression which Bache brought back with him from Europe was the low status accorded there to American science. This had been equally evident to Joseph Henry, whose European tour had coincided

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Robert Adrain (1775–1843)
Artist unknown
Professor of mathematics and vice-provost of the University of Pennsylvania, having previously taught at Queen's College (Rutgers), Columbia, and elsewhere. Born in Ireland, he started teaching at fifteen, being entirely self-taught after this age. Forced to flee after the Irish Rebellion of 1798, he was recognized for his mathematical genius in the United States where he accomplished the first original work in pure mathematics, a deduction of the law of probability of error in observation. This appeared in the Analyst, a publication edited by him (1808). His books and manuscripts were presented to the library in 1925.
with that of his friend. Henry had read a paper before a learned society in London and had encountered unwarranted skepticism. The suspicion with which data coming from the United States were viewed was, unfortunately, not without foundation. Some time after his return to Princeton, Henry wrote to Bache:

... The charlatanism of our country struck me much more disagreeably when I first returned than before or even now. I often thought of the remark you were in the habit of making that we must put down quackery or quackery will put down science. ... I am now more than ever of your opinion that the real working men in the way of science in this country should make common cause and endeavour by every proper means unitedly to raise their own scientific character.22

To this endeavor Bache would dedicate his influence and judgment when he set out on a second career as superintendent of the Coast Survey.

A promising student at Central High School who was afterwards employed in the Coast and Geodetic Survey as it was later named, suggests that Bache had some thought of becoming provost of the University of Pennsylvania when he resigned as principal of Central in 1842 to resume his position as professor of natural science.23 The direction of his talents was radically altered, however, by his call to Washington two years later. John F. Frazer who, although only a few years younger than Bache, often addressed him in letters as "Grandpa," served the University as the eleventh vice-provost and succeeded to his friend and mentor's professorship. During years devoted to educational research and administration, Bache had neither "relinquished or deferred the scientific pursuits to which the habit of his mind and the bent of his genius continually impelled him."24 Now, this advocate of basic research found himself in the employ of the federal government, in charge of the largest practical application of scientific principles ever sponsored by government funds.

Under his tutelage, the magnetic survey became a continuing study: it was extended from the Atlantic Coast to those of the Pacific and the Gulf. Telegraphy was developed in its service, and it included astronomical research, the measurement of mountains, and investigations of the Gulf stream and the tides. Allotment of funds for these ever-widening projects was violently attacked in Congress—and defended with equal vehemence. Jefferson Davis, although sick, "was taken in a close carriage up to address the Senate on an appropriation for the coast survey," for, he said, "It is for the good of the country and for my boyhood's friend Dallas Bache, and I must go if it kills me."25 The Coast Survey not only became a model for large-scale scientific investigation sponsored by government: with the arrival in Washington of a scientist to head the organization, pure
science became both antecedent and ancillary to applied science. The end product was practical and justification enough for government financing. But under Bache, numerous scientists were engaged in developing new methods and exploring phenomena of basic scientific interest.

Having dominated the scientific scene in Philadelphia, Franklin's descendant now became the acknowledged “Chief” of an eminent group of investigators in Washington as well as at the universities. These men all shared a common ambition: that of developing a community of professional scientists in America. Shortly after his arrival in Washington, Bache was instrumental in persuading Joseph Henry to leave Princeton, where he was professor of geophysics, to become the first secretary of the Smithsonian Institution. The intimates of Bache and Henry, who were for the most part involved with the physical sciences, soon became the dominant influence of the newly formed American Association for the Advancement of Science. This society superseded the Association of American Geologists which Henry D. Rogers, the first professor of mineralogy and geology at the University of Pennsylvania, had helped organize in Philadelphia in 1840. Bache was the second president of the AAAS when it held its first formal meeting in September 1848 in the Hall of the University of Pennsylvania. In the speech he made on retiring from this position in 1851, he emphasized the need to give “pre-eminence to research over the literature of science.” On the same occasion, he advocated government patronage and the establishment of a responsible body which would serve to screen proposals and prevent the government from investing in irresponsible projects.

The threat to science from quackery which Bache and Henry had recognized in the thirties continued and by the time of the Civil War was seen as a real danger. At that time, Benjamin Peirce took up the cudgels in an attack on “charlatanism” and “old fogeyism” by underlining the menace to the government from “amateurs and tinkerers.” Peirce foresaw a disastrous fate for true science. “Amid the din of war, the heat of party, the deviltries of politics, and the poisons of hypocrisy,” he protested, “science will be inaudible, incapable, incoherent and inanimate.” A society of like-minded scientists calling itself the Florentine Academy had been formed in Harvard, and this soon became part of a national movement under the leadership of Bache. One of the stated purposes of this unofficial body was “once per winter” to consume “one outrageously good dinner together.” Its members became known as the scientific Lazzaroni, after a society of Neapolitan beggars.

In their search for government support for science these beggars of Lazarus were accused of elitism and sometimes referred to as a Cambridge clique. In fact, under the leadership of Bache, they included among their number scientists from Philadelphia, Cambridge, Albany, New York, and New Haven—the people Henry had meant when he wrote of “the real
"The President's House"
Steel engraving by Traversier, 1837
Collection of Mrs. Martin Meyerson
The French traveler J. B. G. Roux de Rochelle included this view of the University on Ninth Street in his book on the United States published in Paris by Didot Frères. Depicted is "The President's House," erected for but not used by President John Adams while Philadelphia was the national capital and purchased by the University in 1800. Architect Benjamin Henry Latrobe designed the wing on the left to house the medical department. The handsome Adam-style mansion was demolished and replaced by a new building in 1829.

working men in the way of science." Only a small number of biologists belonged to the group, but few dominant figures in the physical sciences remained outside it. Most of the research in progress at the universities or elsewhere was in the hands of their associates. Their ultimate goal of respected professionalism and recognition by government was achieved in 1863, the year the National Academy of Sciences was founded in response to their efforts. Although Henry was not a party to the final establishment of this body, finding the concept "something at variance with our democratic institutions," he was included as one of the fifty original members after the proposal had been skillfully pushed through Congress by Senator Henry Wilson of Massachusetts.31

Problems naturally arose because certain deserving investigators were omitted from the body while nonscientific men from the army and navy were included. But the event was seen as recognition of the relation of science to government and, more important, the need for a central body to screen the scientific soundness and content of proliferating inventions, the result of a developing technology. After the legislation had been signed into law, Louis Agassiz, the renowned Swiss scientist and one of the few naturalists among the Lazzaroni, wrote gleefully to Bache: "My dear young Chief, Yes there is a National Academy of Sciences." He went on to propose arrangements for its inaugural meeting:

Now let us proceed to organize in such a way, that our action shall bear the nearest scrutiny. I wish our first meeting would have some solemnity. It were best to gather for the first time in Philadelphia in some of the hallowed places of Revolutionary
During his lifetime, Bache earned the reputation of being a worthy descendant of his great forebear. If Agassiz accused Franklin of a notable omission in the service of science, it was one which Dallas Bache was to help rectify. Building on the legacy of the eighteenth century when science was an area for amateur investigation by the enlightened philosopher, Bache and his associates raised it to a level of scholarly professionalism and heralded its position in the modern world. Bache survived the foundation of the Academy by only a few years, and, in the early days, it did not live up to the hopes of its first supporters. The advisory capacity which he had envisaged was slow to be recognized, and the projects channeled to it for investigation were few and far between. Yet, in the same way as he had striven to set up this symbol of high-level science during his life, Bache continued to promote its fortunes at the time of his death. He willed the National Academy of Sciences the bulk of his estate. Another important development was Joseph Henry's decision to accept the presidency as a debt of friendship to Bache. By converting its aims from government service to the support of research, Henry helped place the National Academy on a secure scientific footing and assured its future of significant service which had been the cherished object of Bache and the Lazzaroni.