THE HUDSON RIVER VALLEY REVIEW

A Journal of Regional Studies

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From the Editors

The historical net in this issue of *The Hudson River Valley Review* has been cast especially wide, spanning from the early eighteenth century right up to the twenty-first. The range of topics—from linguistics and engineering to urban geography—is also unusually broad. Taken together, these articles comprise a fascinating tapestry that truly represents the diversity of thought and activity that has always been a distinguishing characteristic of life in the Hudson Valley. Such diversity is what continues to make the region a center for creativity and makes *The Hudson River Valley Review* so much fun to edit—and, we hope, fun and informative to read.

Reed Sparling
Christopher Pryslopski

Letter To the Editors

One note regarding Christopher Pryslopski's intriguing article on the Orange County Government Center. The description of Goshen's main street as "...an historic island in a growing sea of suburban sprawl with endless stretches of red lights, turning lanes, and big-box retail centers" is quite simply well-over-the-top hyperbole—and not justifiable by any real review of the full Goshen area landscape. As a leading anti-sprawl advocate, I know it when I see it. This hyperbole blemishes the article, regurgitates popular PR/media terminology, and certainly is not based on research or analysis.

Back to Rudolph's design: for now I will stay out of the debate on the merits of this example of modernist architecture or its functional use as a public facility. It is unique, but many of us have our own practical frustrations with the building. Its one element that particularly frustrates me, and many others, is that most of the stairwells were not designed or built wide enough to accommodate two people side-by-side. So when someone goes up or down the stairs, they typically have to wait, or go flat against the wall, to allow another person to go down or up. This just isn't practical in a heavily used public building.

David Church, Commissioner
Orange County Planning Department, Goshen

Call for Essays

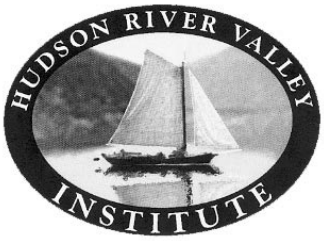
The Hudson River Valley Review is anxious to consider essays on all aspects of the Hudson Valley—its intellectual, political, economic, social, and cultural history, its prehistory, architecture, literature, art, and music—as well as essays on the ideas and ideologies of regionalism itself.

Submission of Essays and Other Materials

HRVR prefers that essays and other written materials be submitted as two double-spaced typescripts, generally no more than thirty pages long, along with a computer disk with a clear indication of the operating system, the name and version of the word-processing program, and the names of documents on the disk. Illustrations or photographs that are germane to the writing should accompany the hard copy. Otherwise, the submission of visual materials should be cleared with the editors beforehand. Illustrations and photographs are the responsibility of the authors. No materials will be returned unless a stamped, self-addressed envelope is provided. No responsibility is assumed for their loss. An e-mail address should be included whenever possible.

Under some circumstances, HRVR will accept materials submitted as an e-mail attachment (hrvi@marist.edu). It will not, however, open any attachment that has not been announced and cleared beforehand.

Since HRVR is interdisciplinary in its approach to the region and to regionalism, it will honor the forms of citation appropriate to a particular discipline, provided these are applied consistently and supply full information. Endnotes rather than footnotes are preferred. In matters of style and form, HRVR follows *The Chicago Manual of Style*.



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On the cover: *West Point Looking South* by George Catlin; circa 1828
Courtesy of West Point Museum Art Collection, United States Military Academy

ALL IMAGES COURTESY UNITED STATES MILITARY ACADEMY AT WEST POINT

Cadets building a pontoon bridge on the Hudson

The Hudson River Valley's Influence on Engineering Education in the United States

Bruce Keith & James Forest

> There is a poetic power in the Highland setting where West Point reposes and in the river that the post commands. It perhaps derives from the incongruous path the Hudson has chosen—rising some three hundred miles from the sea in a tiny, high Adirondack lake and behaving for much of its course as a river should until, just above West Point, it leaves its valley and slices east through the granite Highlands in a narrow, twisting, picturesque forge of its own making. —Theodore Crackel[1]

At the point of this western forge in the Hudson River Valley lies the United States Military Academy. While not as old as the forge itself, the academy has become synonymous with this geological formation commonly referred to as West Point. In the eighteenth century, the Hudson River was of strategic importance to the emerging nation. Those who controlled the river controlled the transportation of supplies and communication networks to the central and southern colonies. West Point was one of the few places along the river where this vital inroad into the colonies could be defended from external interests.

West Point emerged from being essentially a military post to a military academy in an effort to provide the young nation with sufficient expertise in the engineering of fortification and gunnery.[2] Before the creation of the Military Academy, few colonists were educated or experienced in the field of engineering. During the Revolutionary War, for example, the Continental Army suffered from a critical lack of engineers. George Washington, as its commander, was forced to rely exclusively on foreign engineers to support it. In 1778, he issued a formal call for a school of engineering.[3] Similarly, John Adams remarked in 1776 that "Engineers are very scarce, rare, and dear…we want many and seem to have none. I think it is high time we should have an Academy of this education."[4] In response to these

concerns, Congress established the Army Corps of Engineers in 1794. That same year, at the recommendation of President George Washington, Congress also legislated provisions for a school of artillerists and engineers. Concluding that the service of engineers was not limited to the construction of military fortifications, James McHenry, then Secretary of War, argued in 1800 for a school of engineering that could satisfy the needs of both the Army and the nation.[5] In 1802, President Thomas Jefferson formally established the United States Military Academy, to be located in the Hudson River Valley.

With the establishment of the Military Academy, West Point became the 29th school of higher education in the United States.[6] While a college education in the late eighteenth century typically prepared graduates for leadership roles in the ministry, Jonathan Williams, the first superintendent of West Point and head of the Army Corps of Engineers, set out to create a national institute of science oriented toward the study of mathematics and engineering.[7] In 1813, Williams appointed Alden Partridge, USMA Class of 1806, as the country's first professor of engineering. Thus, West Point is credited as being the first engineering school in the United States[8], the first to appoint a professor of engineering, and the first to establish a curriculum focused on mathematics and engineering.

The War of 1812 revealed a lack of technical expertise in military engineering, an indication that the fledgling Military Academy had not yet developed effective programs to address those needs.[9] Following the war, President James Madison and Secretary of State James Monroe sought to strengthen the resolve of the Military Academy for the sole purpose of enhancing the state of engineering education. In 1815, Monroe sent Major Sylvanus Thayer (an 1807 graduate of Dartmouth College and an 1808 graduate of the Military Academy) to France for two years of study at the Ecole Polytechnic, with the intention of learning about its organization and engineering curriculum.[10] Upon his return in 1817, Thayer established the first engineering library in the country at West Point, he personally contributing more than 1,000 books collected during his travel abroad.[11]

Major Sylvanus Thayer

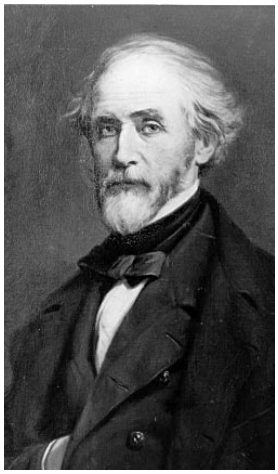
In 1817, with Thayer's appointment as the Military Academy's third superintendent, West Point began to define the curricular scope of engineering education in the United States. Thayer designed a rigorous engineering program with a curriculum centered on the study of mathematics, science, and civil

engineering. He is credited with placing students into four classes, establishing a uniformity and order to the curriculum, instituting annual entrance examinations, and developing a system of evaluation, daily recitation, and discipline based on a standard of high achievement.[12] Thayer's pedagogical approach to learning was a dramatic shift from the apprenticeship model, which had come to characterize the acquisition of knowledge in the technical, legal, and medical fields during the late eighteenth and early nineteenth centuries.

Certainly prior to 1840—and to a great extent up to 1870—West Point and engineering education were synonymous with one another.[13] The Military Academy's influence in engineering education is notable in the number of faculty and graduates who either established programs elsewhere or contributed to the growth and development of the curriculum. Sylvanus Thayer left the academy in 1833 to create the Thayer School of Engineering at Dartmouth.[14] Alden Partridge established Norwich University in Vermont in 1819 and the Virginia Military Institute in 1839. William Norton (USMA 1831) left West Point in 1833 to become professor of civil engineering at New York University. He later served as a professor at Brown, and in 1847 accepted an appointment to become the first dean of engineering at Yale University. Richard Smith (USMA 1834) left West Point in 1856 for a position as professor of mathematics, engineering, and drawing at the Brooklyn Collegiate and Polytechnic Institute. In 1863, he became president of Girard College in Philadelphia. Henry Eustis (USMA 1842) left West Point in 1849 to become professor of engineering in the Lawrence Scientific School of Harvard University, eventually serving as its dean. William Guy Peck (USMA 1844) left the Military Academy in 1855 to serve as a professor of mathematics and mechanics at the University of Michigan, and later Columbia University. William Trowbridge (USMA 1848) resigned his position at West Point in 1856 to become professor of engineering at Yale University; in 1877, he served as professor of engineering at Columbia University. Indeed, among the five founding faculty members of the Columbia School of Mines in 1864, two were from West Point: Francis Vinton (USMA 1833) and Peck.[15]

Charles Davies

Many of the professors on West Point's faculty wrote important textbooks. Charles Davies' *Descriptive Geometry* (published in 1826) and Dennis Mahan's *Elementary Course of Civil Engineering* (1837) set the standard for work in the fields of mathematics



Denis Hart Mahan

and engineering.[16] Rensselaer Polytechnic Institute relied extensively on textbooks written by West Point faculty. Griggs, Jewell, and Ressler show that these texts included Davies' translations of Legendre's *Geometry* (1839) and Bourdon's *Algebra* (1839), as well as his own *Surveying* (1815) and *Descriptive Geometry*; Church's *Analytic Geometry* (1828) and *Calculus* (1828); and Mahan's *Industrial Drawing* (1824) and *Elementary Course of Civil Engineering. Analytical Mechanics* (1826) and *Acoustics and Optics* (1839) by William Bartlett (USMA 1826) and *Elementary Treatise on Mechanics* (1859) by William Guy Peck were also used widely.[17]

Other West Point graduates of the nineteenth century accepted appointments as presidents of colleges and universities. Robert E. Lee (USMA 1829) served as president of Washington and Lee University. Rosewell Park (USMA 1831) served as the first president of Racine College in Wisconsin. Benjamin Ewell (USMA 1832) became president of the College of William and Mary. Josia Gorgas (USMA 1841) served as the president of the University of Alabama. Henry Coppee (USMA 1845) became president of Lehigh University. Oliver Howard (USMA 1854) was the founder and first president of Howard University. Alexander Webb (USMA 1855) succeeded Horace Webster as president of the City University of New York. Benjamin Sloan (USMA 1860) served as the president of the University of South Carolina. Edward Holden (USMA 1870) served as president of the University of California-Berkeley. Lyman Hall (USMA 1881) served as president of the Georgia Institute of Technology.

Academe was but one avenue through which the Military Academy influenced engineering education in the United States. Many of the railroads, canals, and bridges constructed throughout the nation during the nineteenth century were built by West Point graduates. Indeed, as Grayson suggests, most engineers who engaged in public works projects before 1840 earned diplomas from the Military Academy.[18] In addition to establishing and serving as the first president of the National Academy of Science, Alexander Bache (USMA 1825) founded the Smithsonian Institution. Robert E. Lee designed the natural dredging process for the Mississippi River that may have saved St. Louis as a port.[19] Herman Haupt (USMA 1835) served as an engineer for the railroads and invented the pneumatic drill and a bridge truss that bears his name. Montgomery Meigs (USMA 1836) was the construction engineer for the dome and wing extension project of the

Cadets in a classroom, 1897

United States Capitol. George McClellan (USMA 1846) planned the route for the transcontinental railroad. Thomas Casey (USMA 1852) was the construction engineer for the Washington Monument. Notably, Meigs' and Casey's engineering work received such acclaim that they were both elected members of the National Academy of Science.

Throughout the nineteenth century, leaders in higher educational reform acknowledged their debt to the Military Academy. George Ticknor, an educational reformer and president of Harvard in the early nineteenth century, wondered publicly why West Point was superior to Harvard in the seriousness and effectiveness of its examinations, in the scheduling of vacations, and in attention to the business at hand.[20] Somewhat later, in 1850, Francis Wayland, then president of Brown, charged that, "The single Academy at West Point has done more toward the construction of railroads than all our…colleges united."[21] Wayland called for an integrated curriculum based on scientific reasoning and mathematics, which would be applicable to the challenges of a modern society.[22] Indeed, as Ambrose contends, "every engineering school in the United States founded during the nineteenth century copied West Point, and most found their first professors and presidents among the Academy graduates."[23] Speaking at the centennial celebra-

Cadets Studying in Barracks, 1903

tion of the Military Academy in 1902, William Rainey Harper, first president of the University of Chicago, summarized West Point's impact on higher education:

> What, now, is West Point's message to the educational world? This is a question not to be answered in a five-minute speech, and…yet it is possible to state in few words the great ideas for which the Military Academy has stood…. The first of these is concentration of effort…. It's definite purpose has never been lost sight of. Another of these characteristics has been the degree of thoroughness demanded in the work. A third characteristic has been the spirit of subordination, of obedience, engendered in the student…. Such training has evidently produced satisfactory results in all these cases…. I venture to ask…[whether it] would not be well for every boy to have at one stage or another of his development, a period of discipline at all events similar to that which is called military.[24]

Without question, throughout much of the nineteenth century, engineering education was directly influenced and shaped by those with ties to the Hudson River Valley.

The Institutional Expansion and Professional Growth of Engineering Education

The intellectual foundation created by West Point during the nineteenth century provided the impetus for engineering education in the twentieth. As the nation expanded and universities were established to focus directly on the profession, the influences of faculty at other universities became more pronounced. The expansion of engineering education throughout the United States was greatly enhanced by the Congressional enactment of the Morrill Land-Grant Act of 1862, which stimulated the rapid extension of engineering education. Between 1862 and 1876, sixty-three engineering schools were established, many with an undergraduate engineering curriculum that mirrored the one at West Point. From 1876 to 1890, the demand for higher education grew rapidly, leading to the founding of new and larger colleges and universities; several of these, including Stanford (1891) and the universities in Pittsburgh (1879), South Dakota (1883), Arizona (1885), Wyoming (1886), Idaho (1889), and Chicago (1892), created ambitious engineering programs. Many of these schools relied on texts that were produced by faculty at West Point. Dennis Mahan's civil engineering textbooks provided a comprehensive review of basics and fundamentals, and his seminal work on bridge design and the construction of roads, canals, and railroads influenced engineering education for decades. Likewise, Herman Haupt's *General Theory of Bridge Construction* remained a widely heralded volume for decades after its publication.[25]

The emphasis on graduate education, first begun at Johns Hopkins University in 1876, dramatically expanded to colleges throughout the country.[26] As the Civil War drew to a close, there were fewer than two dozen engineering schools in the country.[27] By 1870, engineering programs existed at seventy schools, an expansion unparalleled in American higher education.[28] Prior to 1862, upwards of three-quarters of the engineers produced in the country were graduates of the United States Military Academy. Between 1862 and 1876, 1,866 persons received engineering degrees across the nation; less than 500 of them were West Pointers. By the dawn of the twentieth century, the expansion of enrollments in engineering programs at land grant and private research universities dwarfed those at the Military Academy. In 1900, there were approximately 10,300 students enrolled in engineering programs throughout the country; by 1906, enrollments had increased to more than 27,600.[29] By comparison, the Military Academy graduated fifty-four cadets in 1900, another fifty-four during its centennial year in 1902, and seventy-eight in 1906. In 1906, fewer than 350 cadets were enrolled at West Point.[30] The limitations on enrollments there prevented growth comparable to

those seen nationally.

Increasingly after World War Two, the focus of innovation and change in science and engineering education shifted to the research universities, particularly those with large programs of graduate education and sponsored research (e.g., MIT, Michigan, Berkeley, Cal Tech, Cornell, and Illinois). The dramatic expansion of engineering programs throughout the country, and the tremendous growth in the enrollments of engineering students when combined with the Military Academy's sole focus on undergraduate education, gradually lessened West Point's overall impact on engineering education.[31] Moreover, unlike their predecessors in the nineteenth century, the Military Academy's engineering faculty ceased to produce textbooks that were widely adopted by other engineering programs.[32]

Beyond the classroom, engineering education is intricately linked to the application of large-scale engineering projects, where intellectual curiosity must be combined with problem-solving ingenuity. Here, West Point continued to contribute many leaders to complicated engineering projects throughout the twentieth century. George Goethals (USMA 1892) served as the chief engineer for the construction of the Panama Canal from 1904 through 1914.[33] The Alaskan Highway, which runs through Canada, was designed and built by William Hoge (USMA 1916). Leslie Groves (USMA 1918) was director of the Manhattan Project, which gave the world nuclear energy. Previously, Groves (along with Clarence Renshaw, USMA 1929) had been assigned to build the Pentagon. Hugh Casey (USMA 1918) directed the development of the New York City Transit Authority. Ralph Tudor (USMA 1923) served as the senior engineer for the design and construction of the San Francisco-Oakland Bay Bridge. Harvey Jones (USMA 1945), along with William Potter (USMA 1928) managed the planning and construction of Walt Disney World in Orlando Florida. James Lammie (USMA 1953) served as the executive director for the construction of Atlanta's electric rapid transit system. James Endler (USMA 1953) managed the construction of the World Trade Center complex in New York City and designed Disney's EPCOT Center in Orlando. Ralph Locurcio (USMA 1965) led the planning and reconstruction of Kuwait's infrastructure as commander of the Kuwait Emergency Recovery Office.

The U.S. Army Corps of Engineers has a distinguished history of influencing a variety of cutting-edge civil, mechanical, and nuclear engineering projects throughout the world. Forty-one of the fifty-two persons appointed as its chief since its inception in 1775 have been Military Academy graduates. Two others were affiliated with the military post at West Point prior to its establishment as an engineering school. Of historical significance, its second chief, Colonel Rufus Putnam, constructed the fortifications around the post at West Point in 1777

that prevented the British from gaining control of the Hudson River during the Revolutionary War. George Gillespie (USMA 1862) constructed the canal at the Cascades of the Columbia River. William Marshall (USMA 1868) constructed the Illinois and Mississippi Canal. Dan Kingman (USMA 1875) initiated planning for federal cost-sharing with private hydroelectric-power investors for a lock and dam built below Chattanooga, Tennessee. Edgar Jadwin (USMA 1890) oversaw the Mississippi River flood control project adopted by Congress in 1928. Lytle Brown (USMA 1898) directed the construction of the Wilson Dam hydroelectric project in 1919-1920. Raymond Wheeler (USMA 1911) initiated construction of the Missouri River dam projects and oversaw the clearing of the Suez Canal in 1956-1957. Samuel Sturgis (USMA 1918) was the senior engineer for the nation's air forces in 1946-1948 and the Missouri River Division Engineer in 1949-1951.

George Gillespie

Arguably one of the nation's greatest engineering feats ever—the moon landing—and successive space exploration projects involved several West Point graduates. Lew Allen (USMA 1946) was, as a Major General in 1971, responsible for the procurement, launching, and on-orbit operation of the United States' Apollo space effort. Frank Borman (USMA 1950) commanded the first circumlunar flight on Gemini 7 and later flew the Apollo 8 craft. Edwin "Buzz" Aldrin (USMA 1951) participated in the first manned lunar landing. Edward White (USMA 1952), the first American to walk in space, died in an Apollo spacecraft fire in 1967. Michael Collins (USMA 1952) commanded the space module in the first manned lunar landing and also directed the Air and Space Museum. More recently, Michael "Rich" Clifford (USMA 1974) commanded a NASA mission to operate a fluid transfer experiment and laser detector. Charles "Sam" Gemar (USMA 1979) served on a NASA mission to deploy the Upper Atmosphere Research Satellite. Jeffrey Williams (USMA 1980) served on a shuttle mission devoted to the construction of the International Space Station. Don Peterson (USMA 1955), James Adamson (USMA 1969), William McArthur (USMA 1973), and Douglas Wheelock (USMA 1983) also participated in space shuttle missions.

Taking Stock: Looking Back Toward the Future

West Point has shown itself to be an indelible institution, one that has effectively weathered changes in higher education over the past two centuries. In many respects, its influence is analogous to that of a tree. Initially, the tree stands alone in a field and serves as the most direct source of shade. Over time, saplings from the tree begin to take root. As they mature, the second- and third-generation trees begin to rival the size and dominance of the original tree. In time, the first tree is but one in a forest of trees, largely indistinguishable from the others that now surround it. The Military Academy was the first—and for nearly twenty-five years, the only—engineering school in the country. Its principal charge was to provide engineers for the military and the nation. This it accomplished, as witnessed by the successes of its graduates and faculty in both the military and civil sectors of our society. In time, though, the Military Academy's success was replicated at other colleges and universities. Initially, these more recent entrants into higher education looked to the Military Academy for sustenance and support, most notably in their reliance on a curricular model without equal and academy graduates to staff their engineering schools, as well as their use of textbooks written by USMA faculty. Eventually, as with the growth and development of any successive lineage, these schools forged innovative paths that rivaled that of their ancestor. By the dawn of the twentieth century, West Point was merely one of nearly 100 engineering schools in the country.

Yet West Point's graduates continue to populate and govern many of the nation's most notable engineering programs, and through the recent design of interactive software programs and faculty teaching workshops, they have continued to expand the parameters of engineering education. But the Military Academy's greatest impact on the state of engineering education is perhaps not so much what its graduates and faculty have accomplished during the last two centuries, but the indelible and symbiotic relationship it maintains with other engineering schools across the nation. Somewhat analogous to an elder statesman, West Point today benefits from the strength of the field it helped to establish. While no longer solely dominating the direction of engineering education as it did during the nineteenth century, it is one participant in a community of learners seeking to anticipate and effectively respond to the challenges of a changing world.

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Sue Ketterer, Kip Nygren, Bruce Oldaker, William Streett, Janet Reihner, Steve Ressler, Gene Ressler, Wayne Whiteman, and Victor Schutz. Nonetheless, the views expressed herein are those of the authors and do not purport to reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

Notes

1 Theodore J. Crackel. *West Point: A Bicentennial History.* (Lawrence, KS: University of Kansas, 2002), p. xi.

2 Crackel, *West Point*, p. 36.

3 Lawrence P. Grayson. *The Making of an Engineer: An illustrated History of Engineering Education in the United States and Canada.* (New York: Wiley and Sons, 1993), p. 18.

4 Ibid.

5 Grayson, p. 22.

6 Donald G. Tewksbury, *The Founding of American Colleges and Universities Before the Civil War,* (New York: Columbia University Press, 1965:32-36), shows that 28 colleges in the United States predated the establishment of the Military Academy. These include Harvard (1636), William and Mary (1693), Yale (1701), Princeton (1746), Columbia (1754), Pennsylvania (1755), Brown (1765), Rutgers (1766), Dartmouth (1769), Washington-MD (1782), Washington and Lee-VA (1782), Hampden-Sidney-VA (1783), Transylvania (1783), Dickinson (1784), St. John's (1784), Georgia (1785), Charleston (1785), Franklin and Marshall (1787), North Carolina (1789), Vermont (1791), Williams (1793), Bowdoin (7194), Tusculum—TN (1794), Tennessee (1794) Union-NY (1795), Middlebury (1800), Ohio (1802), Washington and Jefferson—PA (1802).

7 Frederick Rudolph. *The American College and University.* (New York: Knopf, 1962), p. 228.

8 The American Society of Civil Engineers designated West Point as "the oldest extant institute in the United States to offer formal academic instruction in the field of civil engineering."

9 William B. Streett. "The Military Influence on American Engineering Education." *Cornell Engineering Quarterly.* Winter 1993, p. 4.

10 Streett, p. 4.

11 James R. Endler, *Other Leaders, Other Heros: West Point's Legacy to America Beyond the Field of Battle.* (Westport, CT: Praeger, 1998), pp. 4-5.

12 Stephen E. Ambrose. *Duty, Honor, Country: A History of West Point.* (Baltimore: Johns Hopkins Press, 1966), pp. 72-74; Endler, pp. 9-11.

13 Ambrose, pp. 120-24; James L. Morrison, Jr., *The Best School in the World.* (Kent, OH: Kent State University, 1986), pp. 110-11; Christopher Jencks and David Riesman, *The Academic Revolution* (Garden City, NY: Doubleday, 1968), p. 220.

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16 William L. Ross and William A. Ross, "Early Influences of the U.S. Military Academy on Engineering and Engineering Graphics Education in the United States." *Engineering Design and Graphics Journal.* 56(1):25, 26; Ambrose, p. 92.

17 Francis E. Griggs, Thomas Jewell, and Stephen J. Ressler, "Early Engineering Education in the United States Prior to 1850," Proceedings of the 2001 Civil Engineering Conference and Exposition, American Society of Civil Engineers, Houston, Oct 10-13, 2001.

18 Grayson.

19 Griggs, Jewell, and Ressler.

20 Rudolph, pp. 119-120.

21 Cited in Rudolph, p. 238.

22 Rudolph, pp. 119-20.

23 Ambrose, p. 91.

24 William R. Harper. "American Universities and Colleges, in *The Centennial of the United States Military Academy. Volume I: Addresses and Histories*. (West Point, NY: United States Military Academy, 1902), pp. 113-116.

25 James G. McGivern, *First Hundred Years of Engineering Education in the United States: 1807-1907* (Spokane, WA: Gonzaga University Press, 1960), p. 38; Emmerson, pp. 236-37.

26 Lawrence R. Veysey. *The Emergence of the American University*. (Chicago: University of Chicago, 1965).

27 Grayson, pp. 40-41.

28 Grayson, p. 43.

29 McGivern, p. 155.

30 United States Military Academy. *Register of Graduates* (West Point: United States Military Academy, 1976).

31 McGivern, p. 201, acknowledges that Dartmouth's Thayer School of Engineering was structured similarly to West Point. It was established with a gift from Sylvanus Thayer, who stipulated the requirements for admission, the curriculum, and the first director of the school. Robert Fletcher (USMA 1865) was appointed director of the Thayer School in 1871 and held the position for 47 years, retiring in 1918.

32 West Point's engineering faculty in the 20th century were not engaged in activities comparable in scope to those of their 19th-century predecessors. Walter Scott Dillard, *The United States Military Academy, 1865-1900: The Uncertain Years* (Ph.D. Dissertation, University of Washington, 1972), portrays an image of the Military Academy's faculty as insular; Roger Hurless Nye, *The United States Military Academy in an Era of Educational Reform, 1900-1925* (Ph. D. Dissertation, Columbia University, 1968) and George S. Pappas, *To The Point: The United States Military Academy, 1802-1902*, (Westport, CT: Praeger, 1993, p. 388-89) show that from 1904 through 1959 West Point's engineering curriculum remained largely intact and unchanged. Pappas suggests that West Point replaced Thayer's prominent civilian "old guard" professors with military officers who would fall directly under the command of the Superintendent. Moreover, Pappas argues that Congress further reduced the Military Academy's influence on engineering education by removing the Chief of the U.S. Army Corps of Engineers as the academy's legislative liaison, a position in effect since the establishment of West Point. The governing authority of the Military Academy became increasingly more insular, and with this trend, less influential in shaping the direction of engineering education beyond its fortified walls.

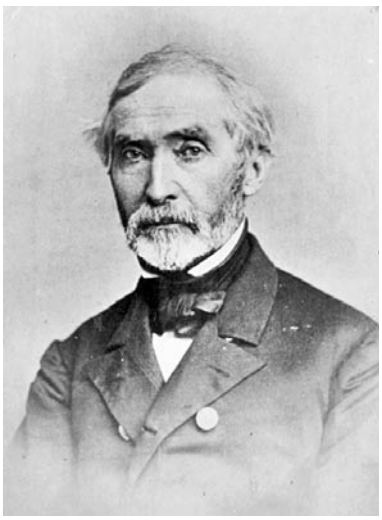
33 The American Society of Civil Engineers lists Goethals and the Panama Canal project as one of a handful of landmark projects completed by persons from the United States. For more information, see the ASEE Web site, *www.asce.org/history*.

Dennis Hart Mahan and the Early Development of Engineering Education

Col. Kip P. Nygren

Born less than a month after the United States Military Academy was founded, Dennis Hart Mahan arrived at West Point in the summer of 1820 to begin his plebe year. The following year, he began teaching fourth-class mathematics as an acting assistant professor, and except for a four-year period in Europe to further his education, he continued to teach at the Military Academy until his death fifty years later.

During that half-century span, West Point was the premier engineering institution in the nation, and Dennis Hart Mahan was the embodiment of the Military Academy for both its graduates and the general public. He was America's preeminent engineering professor and a prolific author of many of the textbooks used in a growing number of engineering programs at other colleges. A national figure in science and engineering, he was one of the fifty original corporators of the National Academy of Science in 1863, one of only six honorary charter members of the American Society of Civil Engineers when it was formed in 1853, and the recipient of honorary degrees from Princeton, Brown, Columbia, and Dartmouth. Mahan was a larger-than-life academic figure with the credibility, academic experience, body of written work, and disciples spread throughout higher education to influence the direction of engineering education well into the following century.



COURTESY UNITED STATES MILITARY ACADEMY AT WEST POINT

Dennis Hart Mahan

As if these achievements were not enough, Mahan was also the major figure in the development of military art and

science in the U.S. Army. He wrote the majority of the Army texts on military tactics and fortifications used during both the Mexican and Civil Wars. (Much to Mahan's chagrin, even the Confederate government published his military books.) Many of the major national figures during and immediately after the Civil War—including Ulysses Grant—had been his pupils. As a further indicator of Mahan's innate brilliance, his son, Alfred Thayer Mahan, became the most influential naval theorist of the early twentieth century.

Though only five feet six inches tall—small even by the standards of the early nineteenth century—Mahan was a brilliant and diligent student. In November 1821, he was appointed an acting assistant professor. He taught a section of plebe mathematics every morning, an assignment that continued until his graduation in 1824. As an instructor, Mahan had several privileges: a special room, an extra ten dollars a month, excusal from most military duties and inspections, and authority to wear a distinctive uniform.

The extra teaching burden and the need to make up work his classmates received during the formal instruction he missed required Mahan to labor even harder. In the 1824 graduation class, he was the top cadet in every subject except French (where he ranked third) and conduct (ninth). A good indicator of the quality of his intellect was the Academic Board's recommendation that Mahan alone be appointed to the Corps of Engineers. Most significant for his future was the impression Mahan made on Superintendent Sylvanus Thayer. Even at this early stage, Thayer believed that he had discovered a budding star for his faculty upon which he could continue to expand his vision for West Point. He would continue to mentor and develop the qualities of this young teacher over the next forty-seven years.

Immediately after graduation, Mahan took up his first and only Army assignment other than teaching at West Point when he reported for duty in New York City to perform several engineering surveys. However, that July he received orders to report back to West Point to become an assistant professor of mathematics. After a year spent mainly in scholarly pursuits, Thayer appointed Mahan principal assistant professor of engineering. He worked closely with the other assistant engineering professor, Alexander Bache, who had just graduated. Thus began a lifelong friendship between two of the most important scientific and engineering leaders of nineteenth-century America.

During 1825, Mahan's health, always frail, deteriorated. In March of the following year, he was unable to teach for two weeks. He requested a leave of absence for a year to visit Europe and regain his health. The leave, which turned into a four-year professional visit to observe engineering practice and education,

included sixteen months at the French Military School of Application in Metz. This experience with certain aspects of the French educational system undoubtedly contributed to the formulation of Mahan's educational philosophy, as it had Thayer's a decade previous. "These aspects were: a small student body and small classes, a closely prescribed curriculum with a heavy mathematical bias, an arduous daily program of frequent grading and recitation, spirited competition for class standing, professors with prestige and considerable power where their courses were concerned, and a director of studies who supervised all aspects of instruction."[1]

Mahan finished his studies in France and arrived back in New York on July 1, 1830. He was promptly assigned to West Point with duty as assistant professor of engineering. The current professor, David B. Douglass, resigned that September, after a dispute over a desired one-year leave of absence. Within a week of receiving Douglass's resignation, the chief of the engineers offered the professorship to Mahan. Thus began the longest tenure of a department head in the history of the Military Academy.

Mahan's extensive and momentous professional contributions during his long career can be categorized as shown below. Only the first two areas of contribution will be addressed in this article.

- Creating an engineering education program
- National leadership and influence in engineering education
- Creating a military art and science education program
- Serving as West Point leader and academy spokesman

At the time Mahan became the Professor of Engineering, no other college in the nation had yet graduated an engineer, although Rensselaer Polytechnic Institute had already initiated its engineering program. The distinction between military and civilian engineer was only recently becoming recognized and would be aided by the expansion of railroads for purely civilian purposes. With no other American engineering programs to use as a model, Mahan was forced to organize both military and civilian engineering in the best manner to support the mission of the Military Academy. "Though able men like Professors [Claudius] Crozet and Douglass had preceded, such were the advancing requirements of the engineering art that it may be said Mahan had to almost recreate his entire course of instruction."[2]

More than almost any other aspect of his service to West Point and the engineering profession, Mahan saw the writing of textbooks—and, therefore, the creation of the structure of engineering education—as his lifetime work. Initially, he used a lithograph press that he purchased for the academy while in France as a means of providing his students with the written information they needed to

study before class. During his entire tenure as professor, Mahan never stopped publishing and revising his long list of textbooks. During summers, he traveled to other colleges and engineering sites to gather the knowledge required to keep his engineering courses current. His textbook, *Course in Civil Engineering*, first published in 1837, sold more than 15,000 copies over its lifetime, with numerous updates and new editions from Mahan.

Over his fifty years as a teacher, Mahan saw the amount of engineering information, especially as applied to the military, literally explode. He understood that one could not teach students all the information they needed; therefore, he concentrated on the teaching of fundamentals and depth over breadth of topics covered. He believed that if a man really understood his principles, he would seldom have difficulty applying them. Mahan often reminded his son, Frederick: "My boy, remember one thing—the only really practical man is the one who is thoroughly grounded in his theory."[3]

All departments at West Point taught cadets in accordance with Thayer's basic concepts. Obviously, after teaching for many years, Mahan had developed his own interpretations of this philosophy. "His cardinal principle was that the studies of the cadets, to be thorough, must be restricted to but a few subjects, that the mind that may act healthfully and be developed by their study in its proper sense, and not merely the memory crammed."[4] Rather than promote superficiality, Mahan omitted material from his curriculum and would advocate extensive individual background readings for the further development of cadets and faculty alike. Today, we call this the independent learning process.

According to George Cullum, one of Mahan's students, the professor was a master at in-class assessment techniques. "He had an almost intuitive perception of the exact amount of information possessed by each cadet on the subject matter of the lesson in hand, and by a few dexterous questions would quickly winnow the kernel of knowledge from the chaff of pretension."[5] Mahan had very high expectations of cadets and he would not tolerate inadequate preparation for class. The students demonstrated their understanding of the important concepts of the lesson either at the blackboard or through oral questioning. "He was stern and unyielding where duty was concerned. There was nothing involving the cadet's responsibilities, which irritated professor Mahan more than neglect of studies and attendant slipshod performance in the section room."[6] By the time a class reached its final year, it was rare that a cadet was discharged for academic failure. It is an indication of Mahan's serious attitude toward education that the only first class (senior) cadets separated from the Academy for academics from 1832 to 1870 were four recommended by him in his course.

Mahan's primary influence on both engineering education and practice was through the impact of his students as they came to develop other engineering programs. "Six of the nine [engineering] schools springing up later than the Military Academy and prior to the Civil War were launched in successful careers with West Pointers in key positions on their respective faculties. And of the total nineteen other [engineering] schools up to 1870, at least ten had direct West Point pedagogical affiliations."[7] Another telling measure of Mahan's influence can be deduced from *West Point's Scientific 200: Celebration of the Bicentennial Biographies of 200 of West Point's Most Successful and Influential Mathematicians, Scientists, Engineers, and Technologists*. Of the graduates listed, eighty-eight were taught and inspired by Dennis Mahan. Sixty-six of these became professors, either at the Military Academy (thirty-nine) or at other universities (thirty-seven), and continued the model of engineering education they had learned from Mahan.[8]

Morrison's examination of the Register of Graduates found that of 1,449 graduates between 1833 and 1866, forty-three were college professors at Columbia, Harvard, Yale, Michigan, Lehigh, California, the University of the South, the University of Georgia, the Virginia Military Institute, the U.S. Naval Academy, Seton Hall, Louisiana State University, Missouri State University, the University of Rochester, and the University of Mississippi. An additional fifteen graduates served as heads of colleges and universities, including VMI, Girard College, the University of Alabama, Washington and Lee, Mississippi A&M, Norwich University, and the University of South Carolina, as well as the state military institutes of Maryland, Kentucky, Alabama, Georgia, and North Carolina.[9] When one considers that West Point graduates—and Mahan's students in particular—became the foundation for a majority of U.S. engineering education programs, the reach of the curriculum and pedagogy of this exceptional professor is broad, indeed. "Technical education everywhere in the early United States showed the pervasive influence of West Point and the Thayer System."[10] "Faculty and graduates of the Military Academy were sought by other colleges and universities, not only because of their knowledge of science, mathematics and engineering, but also because of their familiarity with Thayer's system of rigid discipline, departmentalized study, and intense academic pressure exerted on students."[11]

It is clear that Mahan, as the senior member of West Point's Academic Board for more than thirty years, exerted a strong influence over the development of the curriculum. "From the surviving evidence it is a fair guess that three men —Mahan, [William] Bartlett, and [Albert] Church—dominated the Academic Board. One of these three headed every committee of the Board from 1833 through 1854, and bearing in mind that most of the substantive work of the Board

was accomplished through committees, the conclusion is irresistible that Mahan, Bartlett, and Church governed the academic side of West Point."[12] Mahan was the clear leader of this group; some records even refer to him at the "Dean" of the Academic Board.[13] Morrison concludes that, "The ubiquitous and gifted Dennis Hart Mahan was undoubtedly the pre-eminent figure of the entire group of professors and instructors."[14]

During his years at the academy, Mahan was also the most prolific writer in defense of the institution as it trod through some troubled times, and he identified with West Point in a very personal manner. "Possessed of a brilliant intellect and a facile pen, Mahan employed both to add to the luster of the Military Academy and to the Army in a way none of his colleagues ever did."[15] "As the senior graduate who had not been retired, and the educator of all then in active service, Mahan naturally felt that the Army was in no small measure his own creation, and he was somewhat the foster-father of a numerous progeny of which he was justly proud; hence he was quick to shield worthy officers from unmerited reproach, or sound the praises of…his distinguished children well known to fame."[16]

While Mahan and his West Point colleagues led the academic program, they continued to revise the curriculum, write textbooks, and provide the Army and the nation with technically qualified military officers, engineers, and leaders. An example of their willingness to consider change was the experiment with a five-year curriculum from 1855 to 1860. Ultimately, this failed to produce the desired effects, but such an extensive attempt to overhaul the curriculum was not to be seen again until the First World War. The vitality of Professor Mahan remained at a high level, as evidenced by a letter he wrote to the superintendent in 1867, recommending changes to the role of the Academic Board. While not a new suggestion, Mahan proposed the creation of the position of Dean:

> Fearing West Point was becoming a closed corporation ruled by professors and immune to outside influences, he proposed a Dean between the Supt and the Academic Board, while the Academic Board would only determine proficiency on the examinations. Prophetically, the old professor warned that the governmental structure of West Point has not vitality within itself and cannot have as under a certain set of men everything must be kept stationary, or retrograde.[17]

With the death of Mahan in 1871, and Thayer in 1872, the last links with the reality of Thayer's system was cut. "The Thayer System which had once been a pragmatic approach to academic problems and national demands eventually assumed the status of holy dogma."[18] Not one of the successors to Mahan,

Bartlett, and Church over the next half-century and beyond had both the vision and the standing to make major changes to the venerated academic structure, as the future would demand.

Given the extensive, original, and important accomplishments of Dennis Hart Mahan over the longest tenure of any department head at the United States Military Academy, it is difficult to ascertain why he is not held in greater esteem in academy history. He is the single most important figure in the initial development of engineering education in this country, and he substantially advanced the development of military art and science for the U.S. Army. Probably no single member of the faculty and staff of West Point embodied the academy so well and so long as he did. In many ways, Mahan's accomplishments on behalf of the institution to which he dedicated his life rival—or even exceed—those of his mentor and idol, Sylvanus Thayer.

Notes

1. Thomas E. Griess, "Dennis Hart Mahan: West Point Professor and Advocate of Military Professionalism, 1830-1871" (Ph.D. thesis, Duke University, 1968), p. 131.
2. George W. Cullum, *Biographical Register of the Officers and Graduates of the United States Military Academy at West Point, New York from Establishment in 1802 to 1890 with Early History of the U.S. Military Acdemy*, 2 vols., vol. I (Cambridge: Houghton Mifflin and Company, 1891), p. 320.
3. Frederick A. Mahan, "Professor Dennis Hart Mahan," *Professional Memoires, Corps of Engineers, U.S. Army and Engineer Department at Large* IX (1917): p. 74.
4. Griess, p. 181.
5. George W. Cullum, "Professor D. H. Mahan," *Army and Navy Journal* IX (1871).
6. Griess, p. 191.
7. R.E. Dupuy, *Sylvanus Thayer: Educator* (West Point: 1940), p. 10.
8. David C. Arney, *West Point's Scientific 200: Celebration of the Bicentennial Biographies of 200 of West Point's Most Successful and Influential Mathematicians, Scientists, Engineers, and Technologists* (Unpublished, 2002).
9. James L. Morrison, *The United States Military Academy, 1833-1866: Years of Progress and Turmoil* (Ph.D. dissertation, Columbia University, 1970), p. 175.
10. William B. Streett, "Military Enterprise and Engineering Education: The American Experience," *Cornell Engineering Quarterly* (1993), p. 10.
11. Ibid.
12. Morrison, p. 92.
13. Cullum, *Biographical Register*, p. 322.
14. Morrison, p. 80.
15. Ibid.
16. Cullum, *Biographical Register*, p. 322.
17. Morrison, p. 283.
18. Ibid.

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